AD-A154 892 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS 1/1
HOUGHTON POND DAM (MA.. (U) CORPS OF ENGINEERS WALTHAM
MA NEW ENGLAND DIV JUL 79

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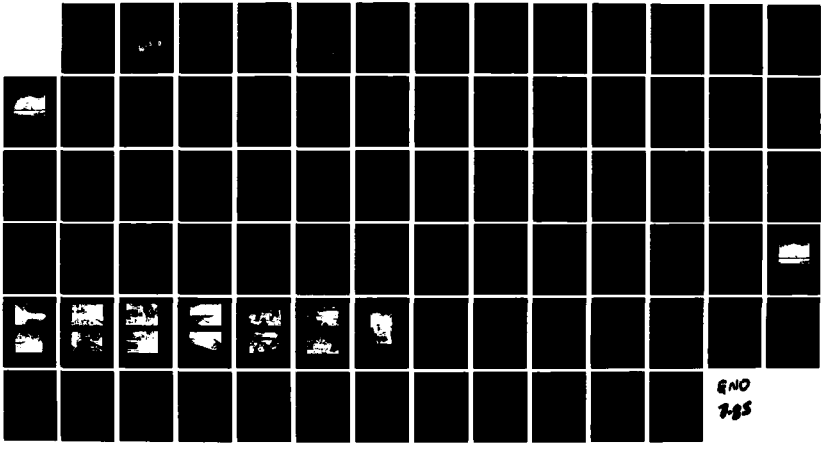
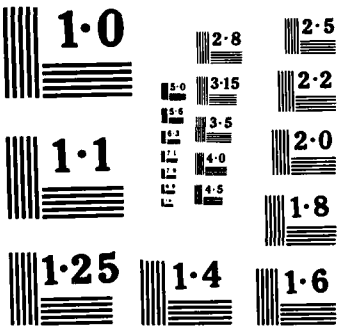


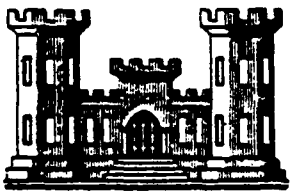


CHARLES RIVER BASIN
HOLLISTON, MASSACHUSETTS

(2)

HOUGHTON POND DAM
MA 00444

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

JULY 1979

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

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18 SUPPLEMENTARY NOTES

Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

19 KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,
Charles River Basin
Holliston, Massachusetts
Tributary to Bogastow Brook

20 ABSTRACT (Continue on reverse side if necessary and identify by block number)

This dam consists of an earth embankment approximately 90 ft. in lenght, a 29.2 ft. long stone masonry auxiliary spillway and a 6.9 ft. long concrete spillway (outlet) structure controlled by stoplogs. The maximum height of the dam is 9.5 ft. The dam is in fair condition, based on visual examination. It has a classification of small and a potential hazard of significant. A professional engineer should be hired by the town to investigate certain apsects of the project.

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF:
NEDED

NOV 13 1979

Honorable Edward J. King
Governor of the Commonwealth of
Massachusetts
State House
Boston, Massachusetts 02133

Dear Governor King:

Inclosed is a copy of the Houghton Pond Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Department of Environmental Quality Engineering, the cooperating agency for the Commonwealth of Massachusetts. In addition, a copy of the report has also been furnished the owner, Town of Holliston.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Department of Environmental Quality Engineering for your cooperation in carrying out this program.

Sincerely,

MAX B. SCHEIDER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

CHARLES RIVER BASIN
HOLLISTON, MASSACHUSETTS

HOUGHTON POND DAM
MA 00444

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

JULY 1979

PHASE I INVESTIGATION REPORT
NATIONAL DAM INSPECTION PROGRAM

Identification No.:	MA 00444
Name of Dam:	Houghton Pond
Town:	Holliston
County:	Middlesex
State:	Massachusetts
Stream:	Tributary to Bogastow Brook
Date of Site Visit:	14 May 1979

BRIEF ASSESSMENT

Houghton Pond Dam consists of an earth embankment approximately 90 ft. in length, a 29.2 ft. long stone masonry auxiliary spillway and a 6.9 ft. long concrete spillway (outlet) structure controlled by stoplogs. The maximum height of the dam is 9.5 ft. The dam was originally constructed prior to 1898, probably to provide water power for a factory. The impounded water is now used for recreation such as fishing.

Due to the extent of downstream development that would be affected in the event the dam were to fail, Houghton Pond Dam is confirmed as having a "significant" hazard potential in accordance with Corps of Engineers guidelines.

The dam is in fair condition, based on visual examination of the structure. Although several deficiencies were noted, there was no evidence of settlement, lateral movement or other signs of structural failure, or other conditions which would warrant urgent remedial action.

Based on the "small" size and "significant" hazard potential classifications in accordance with Corps of Engineers guidelines, the test flood for this dam is one-half the Probable Maximum Flood (1/2 PMF). Hydraulic analyses indicate that the test flood outflow of 1,550 cfs (inflow 1,800 cfs or 690 csm) would overtop the dam by about 2.5 ft. With the water level at the top of dam and the existing stoplogs 6.5 ft. in height in the main spillway, the total spillway capacity is approximately 280 cfs, which is 18 percent of the test flood outflow.

The Town of Holliston, owner of the dam, should engage a registered professional engineer to 1) determine

the design and construction necessary to increase the spillway capacity and provide a low-level outlet, 2) perform a stability analysis of the auxiliary spillway, 3) investigate the seepage occurring from behind the auxiliary spillway and 4) evaluate the effect of clearing trees from the dam, as outlined in Section 7.2. Any necessary modifications resulting from the investigations, and remedial measures, including restoring grade levels on the eroded embankment and left abutment, clearing the embankment, downstream toe and auxiliary spillway approach channel of trees and brush, repairing stone walls and replacing missing stones in the auxiliary spillway weir, as outlined in Section 7.3, should be implemented by the Owner within one year after receipt of this report. The Owner should also prepare a formal operations and maintenance manual for the dam and establish an emergency preparedness plan.

HALEY & ALDRICH, INC.
by:

Harl Aldrich
President

This Phase I Inspection Report on Houghton Pond Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgement and practice, and is hereby submitted for approval.

Joseph W. Finegan

JOSEPH W. FINEGAN, JR., MEMBER
Water Control Branch
Engineering Division

Carney M. Terzian

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

Joseph A. McElroy

JOSEPH A. MCELROY, CHAIRMAN
Chief, NED Materials Testing Lab.
Foundations & Materials Branch
Engineering Division

APPROVAL RECOMMENDED:

Joe B. Fryar

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the office of Chief of Engineers, Washington, DC 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I Investigations are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the test flood is based on the estimated "probable maximum flood" for the region (greatest reasonably possible storm run-off), or a fraction thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential. Consideration of downstream flooding other than in the event of a dam failure is beyond the scope of this investigation.

The Phase I Investigation does not include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

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businesses and commercial buildings surround the channel in this vicinity. The channel passes under Washington Street through a culvert which is rectangular with two 4 ft. by 5.4 ft. openings at the upstream end. The downstream end of the culvert has a single semicircular opening with a 9 ft. base width and a 5.3 ft. height.

About 1,800 ft. downstream from the dam the channel flows into Factory Pond, which has a normal pond area of about 10 acres and an estimated average depth of 10 ft. Flow from the pond is controlled by a 13 ft. long spillway. The top of the concrete sidewalls is about 1 ft. above the spillway crest. Discharge from Factory Pond flows through a rectangular concrete channel and through a culvert under Woodland Street.

An abandoned road, just downstream of Woodland Street, is partially collapsed and dislocated in a manner which blocks the flow in the channel. About 300 ft. downstream from the Factory Pond dam, the channel passes under a stone masonry railroad viaduct which consists of eight 20 ft. spans. The land area beyond the railroad is relatively flat, and the channel meanders through swamps and cranberry bogs.

3.2 Evaluation

Based on the visual examination conducted on 14 May 1979, Houghton Pond Dam is considered to be in fair condition. The noted deficiencies in the dam embankment include heavy growth of vegetation and erosion of the crest and missing stones from the upstream and downstream walls. There is severe erosion and potential for a breach of the dam at the left abutment. These deficiencies are indications of a general lack of maintenance at the dam.

The general condition of the spillways is also considered to be fair. Although the concrete walls of the main spillway (outlet) are in good condition, the stoplogs (wooden gate) are in poor condition and need replacement. The stoplogs are leaking, vulnerable to vandalism, and would be difficult to remove during a period of heavy flow. The field stone masonry auxiliary spillway should be repaired and the flow of water beneath the spillway weir should be stopped.

No. 1 and 11. The top of ground adjacent to the granite weir is from 6 to 15 in. below the top of the granite. At present water level, seepage is occurring below the granite cap and dry-laid boulders on the downstream face at a location 6 ft. right of the concrete spillway, Photo No. 12. It was not possible to trace the flow of water from this point to where it exited downstream. Numerous boulders immediately downstream of the granite weir are missing, either having been plucked out or removed by vandals, Photos No. 4 and 11. Otherwise, the stones appear to be relatively well chinked and are mostly present toward the lower part of the weir, Photo No. 13. Some light vegetation is growing on the downstream face.

At the end of the right wing wall of the concrete spillway (outlet) on the pond side of the dam was a keyed construction joint with reinforcing bars extending beyond the joint. Approximately 20 ft. offshore from the right of the ogee spillway are two concrete piers with bolts. These piers and the observed construction joint in the concrete spillway, shown on Photo No. 3, would tend to indicate that a structure existed at this location some time in the past. Mr. Douglas Brown, Holliston Building Inspector, stated that the piers may be remnants of a ramp leading to an ice house formerly located on the embankment.

d. Reservoir Area. The area around Houghton Pond is entirely wooded. There are one or two homes visible through the trees on the west side. The shoreline has generally modest slopes, and there appears to be little possibility of any landslides or significant erosion into the reservoir.

e. Downstream Channel. The brook below Houghton Pond Dam flows through Holliston and Millis, and joins the Charles River at the border of Millis and Medfield. The channel, in general, has a rectangular shape with a 20 ft. bottom width and 4 to 6 ft. depth to the banks. The banks are overgrown with dense vegetation. Rocks and boulders are observed at the channel bottom, Photo No. 14.

The channel passes through a 5 ft. diameter corrugated metal culvert at a point about 80 ft. upstream from Washington Street (Route 16). Several

tree, Photo No. 6. Several capstones on the wall are missing, Photo No. 7. No seepage or indication of water on the downstream face nor other indications of flowing water were noted, although the area downstream of the wall is wet and swampy, Photo No. 7.

The left abutment of the dam, left of the concrete spillway (outlet) consists of brown, widely-graded sand and gravel. This area is bare and has been severely eroded. The grade immediately adjacent to the concrete wing wall upstream on the left side is about 4 to 6 inches below the top of the concrete, Photo No. 8. Thereafter the grade slopes down until it becomes about 30 inches below the top of the wall at the spillway itself and essentially the full height of the wall at the downstream end, Photo No. 9.

c. Appurtenant Structures. The concrete main spillway (outlet) with stoplogs is located to the left of the stone masonry auxiliary spillway. Considering the different mode of construction between the concrete spillway and the auxiliary spillway, it can be concluded that the concrete spillway was constructed some time after the auxiliary spillway. The concrete portion of the structure is in good condition with some minor spalling and staining observed, Photos No. 8, 9, 10 and 11.

There are blockouts with anchor bolts observed on either side of the stoplog slots at the top of the concrete spillway walls, Photo No. 1. Observation of the stoplogs revealed the remains of two wooden stems bolted to the lower stoplogs. The presence of these stems and the blockouts at the top of the walls would tend to indicate that what appears to be stoplogs may have been a double-stem operated (through rack and pinion gears) wooden gate. The condition of the stoplogs (remains of a wooden gate) are poor, with several leaks observed between the lower stoplogs, Photo No. 10. Remnants of one of the stoplogs could be seen in the channel below.

The auxiliary spillway is constructed of placed field stone masonry with a cut granite spillway weir, Photos No. 4, 11, 12 and 13. The channel approach area to the cut granite spillway weir, a strip of ground approximately 6 ft. in width, is covered with brush and small saplings up to about 4 in. in diameter, Photos

SECTION 3 - VISUAL EXAMINATION

3.1 Findings

a. General. The Phase I visual examination of the Houghton Pond Dam was conducted on 14 May 1979. The upstream water surface elevation was about 0.2 ft. over the stoplogs in the main spillway (outlet) that day or 2.8 ft. below the top of dam.

In general, the project was found to be in fair condition. Several deficiencies which require correction were noted.

A visual inspection check list is included in Appendix A and selected photographs of the project are given in Appendix C. A "Site Plan Sketch", page C-1, shows the direction of view for each photograph.

b. Dam. The following specific items regarding earth embankment right of the spillways were noted:

1. There is a heavy growth of brush and several trees on the upstream side of the embankment, Photos No. 2, 3 and 4. The stone wall on the upstream side has collapsed in some areas; in others, stones are missing. Consequently, severe erosion on the upstream side has developed from 25 to 30 ft. right of the auxiliary spillway, as partially shown on Photos No. 3 and 5.

2. A path which is bare and eroding has developed along the length of the embankment, apparently due to foot traffic, runoff and possibly pond wave action, Photos No. 4 and 5. One large oak about 12 in. in diameter and several smaller trees are growing on the crest adjacent to the downstream wall, Photos No. 5.

3. The dry-laid stone masonry wall on the downstream side tilts outward about 3 to 6 in. at the top for a distance of approximately 35 ft. from the auxiliary spillway, probably due to the root growth of the adjacent large oak

SECTION 2 - ENGINEERING DATA

2.1 Design Data

No design data for the origina_ dam were located.

2.2 Construction Data

No construction data for this dam are available.

2.3 Operation Data

There are no operation records other than one state inspection report and an engineering evaluation report by Whitman and Howard, Inc. of Wellesley, Massachusetts.

2.4 Evaluation of Data

a. Availability. A list of the engineering data available for use in preparing this report is included on Page B-1. A copy of each listed document is also included in Appendix B.

b. Adequacy. There was a lack of engineering data available to aid in the evaluation of Houghton Pond Dam. This Phase I assessment was therefore based primarily on visual examination, preliminary hydraulic and hydrologic computations, consideration of past performance and application of engineering judgement.

c. Validity. The information contained in the engineering data may generally be considered valid. However, the sketch of the dam included in the state inspection report should not be considered accurate.

2. Length..... Approx. 90 ft.
3. Height..... 9.5 to 10 ft.
4. Top width..... 15 to 18 ft.
5. Side slopes..... Vertical stone walls on U/S and D/S sides
6. Zoning..... Unknown
7. Impervious core..... Unknown
8. Cutoff..... Unknown
9. Grout curtain..... Unknown

h. Diversion and Regulating Tunnel. Not applicable

i. Spillway

1. Type..... Main spillway has concrete training walls with stoplogs. Auxiliary spillway has stone masonry weir and ogee-shaped D/S face
2. Length of weir..... Main spillway - 6.9 ft. Auxiliary spillway - 29.2 ft.
3. Crest elevation..... Main spillway - El. 178.0 Auxiliary spillway - El. 179.4
4. Gates..... None (stoplogs are a maximum of about 6.5 ft. in height)
5. U/S channel..... Main spillway has training walls with width tapering from 20 ft. to 6.9 ft.
6. D/S channel..... About 20 ft. wide, boulders at bottom, dense vegetation on banks

j. Regulating Outlets. There are no regulating outlets that are presently operational at this dam. However, the remains of two wooden stems were observed bolted to the lower stoplogs, suggesting the main spillway (outlet) may have been controlled by a wooden double-stem gate. The present stoplogs, however, could not be readily removed during times of emergency. The dimensions of the outlet without the stoplogs in place are 6.9 ft. wide and 9.5 ft. high with an invert at El. 171.5.

c. Elevation (ft. above NGVD)

1. Streambed at centerline of dam	171.5
2. Maximum tailwater	Unknown
3. Upstream portal invert diversion tunnel	Not applicable
4. Recreation pool	178.0
5. Full flood control pool	Not applicable
6. Main spillway crest (without stoplogs)	171.5
(with stoplogs)	178.0
Auxiliary spillway crest.	179.4
7. Design surcharge-original design	Unknown
8. Top of dam	181.0
9. Test flood design surcharge	183.5

d. Reservoir

1. Length of maximum pool	0.8 mi. (Est.)
2. Length of recreation pool	0.4 mi. (Est.)
3. Length of flood control pool	Not applicable

e. Storage (acre-feet)

1. Recreation pool	55
2. Flood control pool	Not applicable
3. Spillway crest	55
4. Top of dam	132
5. Test flood pool	230

f. Reservoir Surface (acres)

1. Recreation pool	16
2. Flood control pool	Not applicable
3. Spillway crest	16
4. Top of dam	35
5. Test flood pool	50

g. Dam

1. Type	Earth embankment

a. Drainage Area. The total drainage area of Jar (Bogastow) Brook above Houghton Pond Dam is estimated to be 2.6 square miles, as shown on page D-1. Ground elevations in the watershed vary from a low of about El. 180 near the dam to a high of about El. 450 on Bald Hill in the Town of Holliston. About 60 percent of the area consists of rolling woodlands; the remaining 40 percent includes flat residential areas, swamps and the pond.

b. Discharge at Dam Site

1. Outlet works.....	None
2. Maximum known flood at dam site.....	Not available
3. Main and auxiliary spillway capacity* at top of dam.....	280 cfs at El. 181.0
4. Main and auxiliary spillway capacity* at test flood pool elevation (portion of test flood flowing over spillway)..	260** cfs at El. 183.5 (Flow reduction due to high tailwater elevation during the test flood)
5. Gated spillway capacity at normal pool elevation.	Not applicable
6. Gated spillway capacity at test flood pool elevation.....	Not applicable
7. Total spillway capacity* at test flood pool elevation.....	260** cfs at El. 183.5 (Assuming embankment level El. 181.0 along entire length)
8. Total project discharge at test flood pool elevation.....	1,550 cfs at El. 183.5 (Including flow over rest of dam)

* Assuming stoplogs could not or would not be removed
** 1,290 cfs would flow over the rest of dam

(P.O. Box 520, Holliston, MA 02176) is officially designated as the operator of the dam. Mr. John Powell is the current chairman. At the request of the Conservation Commission, the Holliston Highway Department assists in the operation of the dam, most recently by replacing vandalized stoplogs several times in 1979. Mr. Alfred Turner has been Superintendent of the Holliston Highway Department for the past two years. Mr. Turner's office phone number is (617) 429-5895.

g. Purpose of Dam. The earliest reported use of the dam was to provide water power for a nail factory, as shown on a map in the Holliston Building Inspector's office dated 1898. The Rossini family of Holliston formerly cut ice from the pond up until the 1940's. Currently, the pond retained by the dam is used for fishing and also keeps the pond area from otherwise becoming an offensive swamp.

h. Design and Construction History. The dam was apparently built sometime prior to 1898, but no records are available to determine the actual age of the structure. Likewise, no records of the original design and construction of the dam exist. It appears that the concrete spillway structure is of relatively recent construction. Mr. Douglas Brown, Holliston Building Inspector, believes the concrete spillway is at least 40 years old.

i. Normal Operational Procedures. No formal operational procedures for Houghton Pond Dam were disclosed. The stoplogs at the main spillway (outlet) are left in place year-round to maintain the pond at a reasonably constant level. There have been several incidents in 1979 of vandals removing stoplogs and draining the pond to a lower than desirable level.

1.3 Pertinent Data

Without more specific information, all elevations reported herein are approximate and based on the assumption that the top of the stoplogs are at El. 178 National Geodetic Vertical Datum (NGVD), the level of Houghton Pond shown on the 1969 USGS Holliston Quadrangle.

lower than the top of dam. Cut granite boulders have been placed on the downstream slope to give it the configuration of an ogee weir. The auxiliary spillway is shown on Photos No. 1, 4, 11, 12 and 13.

c. Size Classification. Houghton Pond Dam has an estimated maximum storage of 132 acre-ft. at the top of dam. The maximum hydraulic height is 9.5 ft. According to guidelines established by the Corps of Engineers, a maximum storage capacity of less than 1,000 acre-ft. and a maximum hydraulic height of less than 40 ft. classifies this dam in the "small" size category.

d. Hazard Classification. Based on the Phase I investigations and dam failure analysis (Section 5.1f) in accordance with Corps of Engineers guidelines, Houghton Pond Dam was found to have a "significant" hazard potential. If the dam were to fail, a business district upstream of Washington Street (Route 16) which includes a restaurant, a bicycle shop, a transmission repair shop, and a Shell gasoline station on the left bank, and a fire station, a shop and a mini-market on the right bank are expected to be flooded by a 3 to 5 ft. depth of water. In addition, one dwelling on the downstream side of Washington Street and two dwellings on Woodland Street would be flooded to a lesser degree. Therefore, the potential for loss of a few lives and appreciable damage to both industrial-commercial and residential properties exists.

e. Ownership. The name, address and phone number of the current owner are:

Town of Holliston
Board of Selectmen
Town Hall
703 Washington Street
Holliston, MA 01746
Phone: (617) 429-4711

The Town of Holliston acquired the dam in the late 1960's from Kenwood-Holliston Corporation, the developers of Queens subdivision upstream of the dam.

f. Operator. The Holliston Conservation Commission

1.2 Description of Project

a. Location. Houghton Pond Dam is located at the southern end of Houghton Pond, approximately 500 ft. west of the intersection of Routes 126 and 16 in Holliston, Massachusetts, as shown on the Location Map, page vii. The coordinates of the dam site are N42°12.7' and W71°25.7'. Flow from the dam site is conveyed eastward by a small stream tributary to Bogastow Brook.

b. Description of Dam and Appurtenances. Houghton Pond Dam consists of an earth embankment approximately 90 ft. in length with an appurtenant stoplog-controlled main spillway outlet and a stone masonry auxiliary spillway. The total length of the dam is about 150 ft., and its maximum height is 9.5 ft. There are no available design or construction drawings of the project. The "Site Plan Sketch" on page C-1 shows the general configuration of the dam and appurtenances.

The earth embankment is retained by a vertical, dry-laid stone masonry wall on the downstream side and apparently also on the upstream side. The embankment width varies from 15 to 18 ft. The top of the embankment is highest along the downstream wall and then slopes or is eroded toward the pond, such that it is about 1.5 ft. lower along the upstream wall. At the right abutment (looking downstream), the embankment grades into the natural shoreline. The embankment is shown on Photos No. 2 through 7.

At the left abutment of the dam, two 9.5 ft. high concrete walls form the sides of the main spillway (outlet) structure. The 6.9 ft. long weir is formed by stoplogs spanning the outlet from the channel bed to a level 3.0 ft. below the top of the walls. The top of the walls are considered to be the top of the dam, being about the same level or several inches lower than the top of the downstream wall of the embankment. This concrete structure is reportedly of more recent construction than the rest of the dam. The main spillway (outlet) and left abutment of the dam are shown on Photos No. 1 and 8 through 11.

Immediately right of the main spillway and left of the embankment is a 29.2 ft. long auxiliary spillway. It has a cut granite capstone weir about 1.6 ft.

PHASE I INVESTIGATION REPORT
NATIONAL DAM INSPECTION PROGRAM
HOUGHTON POND DAM
MA 00444

SECTION 1 - PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region.

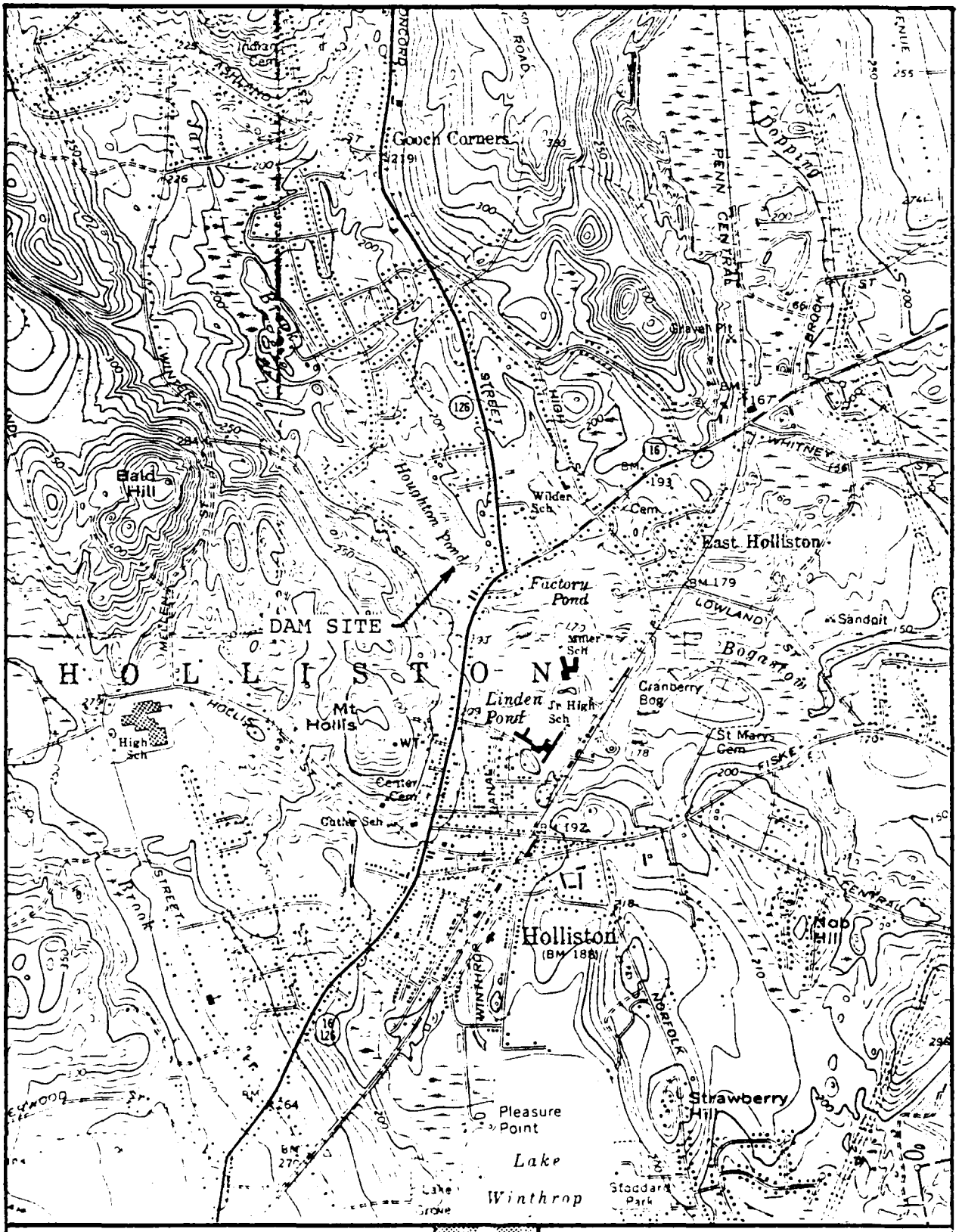
Haley & Aldrich, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Massachusetts. Authorization and notice to proceed were issued to Haley & Aldrich, Inc. under a letter dated 28 November 1978 from Colonel Max B. Scheider, Corps of Engineers. Contract No. DACW33-79-C-0018 has been assigned by the Corps of Engineers for this work. Camp, Dresser & McKee, Inc. was retained as consultant to Haley & Aldrich, Inc. on the structural, mechanical/electrical and hydraulic/ hydrologic aspects of the Investigation.

b. Purpose of Inspection. The primary purposes of the National Dam Inspection Program are to:

1. Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

2. Encourage and prepare the states to initiate effective dam safety programs for non-Federal dams.

3. Update, verify and complete the National Inventory of Dams.



DAM: Houghton Pond

IDENTIFICATION NO. MA 00444

FILE NO. 4270 A31

LOCATION MAP
USGS QUADRANGLE
HOLLISTON, MA

APPROX. SCALE: 1" = 2000'

1. Overview of Houghton Pond Dam from left abutment

SECTION 4 - OPERATIONAL PROCEDURES

4.1 Procedures

In general, there are no formal procedures to provide routine maintenance and satisfactory operation of the dam.

4.2 Maintenance of Dam

There are no established procedures or manuals for inspection and maintenance of the dam. The embankment is generally overgrown by brush and trees, bare and eroded in areas, and apparently has received no recent maintenance.

The severe erosion noted at the left abutment occurred over 10 years ago, possibly during the 1968 storm, according to Mr. Douglas Brown, the Holliston Building Inspector. This is a further indication of the lack of maintenance of the dam.

4.3 Maintenance of Operating Facilities

The operating facility appears to have received little or no maintenance for some time. The condition of project and recommended repairs are noted in an engineering evaluation report by Whitman and Howard, Inc. dated October 30, 1978. The reported conditions are similar to present conditions. Mr. Alfred Turner, Superintendent of the Holliston Highway Department, reports several incidents of stoplogs being vandalized and removed from the spillway outlet in 1979. His department has been requested by the Holliston Conservation Commission to modify the spillway to prevent such vandalism.

4.4 Description of any Warning System in Effect

There is no warning system or emergency preparedness plan in effect for this structure.

4.5 Evaluation

The owner should prepare an operations and maintenance manual for the dam. The manual should delineate the routine operational procedures and maintenance work to be done on the dam to provide satisfactory operation and minimize deterioration of the facility. For example, an annual observation and maintenance program should be established to examine the dam, control vegetation growth and maintain slopes, walls and channels. A formal procedure should be established for the insertion and removal of stoplogs.

Since failure of the dam would probably cause loss of life and extensive property damage downstream, the owner should also prepare and implement a formal emergency preparedness plan and warning system.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. General. The dam consists of a 90 ft. long earth embankment retained by stone masonry sidewalls, a 6.9 ft. long main spillway, and a 29.2 ft. long auxiliary spillway of stone masonry construction. The current purpose of the dam is to maintain the level of Houghton Pond for recreation. The stoplogs at the spillway are left in place year-round to maintain the pond at a constant level.

b. Design Data. No hydrologic or hydraulic design data were available for this dam site.

c. Experience Data. A local resident indicated that in the spring, water normally flows across the top of the auxiliary spillway weir. Also, it was alleged that during the flood which occurred in January 1979, residents adjacent to the pond, complaining about water in their basements, came down to the dam site and cut out several of the stoplogs to lower the water level. As a result, a transmission shop and a restaurant near Washington Street were flooded to a depth of 2.5 ft.

d. Visual Observations. Both the main and auxiliary spillways are located left of the embankment. The approach channel to the main spillway is protected by wing walls. The bottom width of the approach channel is about 20 ft. at the upstream end and tapers down to 6.9 ft. for a length of about 15 ft. The main spillway sidewalls are made of concrete. On the day of the site visit, 0.2 ft. of water was flowing over the stoplogs in the spillway. Because of this, the stoplogs could not be closely observed. However, it appeared that the pond is being maintained at a level approximately 6.5 ft. above the bottom of the downstream channel by a series of about 7 ft. long stoplogs. The auxiliary spillway is made of stone masonry on an embankment with an about one foot high granite cap on the top.

Both banks of the downstream channel are overgrown by dense vegetation including scattered large size trees. The channel flows through a 5 ft. diameter culvert about

80 ft. upstream of Washington Street. The upstream face of the culvert under Washington Street shows a concrete structure with two rectangular openings, and the downstream face is a single semi-circular opening of corrugated steel.

Factory Pond helps to regulate the flows in the channel (Bogastow Brook) to a certain degree. A dwelling is located on a peninsula extending from the left bank. Two more dwellings are located on the left bank, one upstream and the other downstream of Woodland Street. About 300 ft. downstream of the Factory Pond outlet is a railroad viaduct with eight 20 ft. long openings. Flow was through the opening on the furthest left, which has an invert about 4 ft. below the others.

Between the railroad and Lowland Street, about 3,000 ft. downstream of Houghton Pond Dam, the brook spreads over a relatively large swampy area without a well defined channel. Capacity of the culvert under Lowland Street appeared to be relatively small. However, this may not create a flooding problem as the large swamp area upstream from the culvert would probably help considerably to reduce the impact of a peak flow.

e. Test Flood Analysis. Based upon the Corps of Engineers guidelines, the recommended test flood for "small" size dams having a "high" hazard potential is within the range of 1/2 PMF to PMF (Probable Maximum Flood). The PMF was determined using Corps of Engineers Guidelines for Estimating Maximum Probable Discharge in the Phase I Dam Safety Investigations. The watershed terrain was determined to be 60 percent rolling and 40 percent flat. From this, an inflow rate of 1,380 cfs per square mile was interpolated for the drainage area of 2.6 square miles. The resulting PMF inflow is 3,600 cfs.

The 1/2 PMF, or inflow of 1,800 cfs, was adopted for the test flood analysis. Surcharge-storage routing was performed through Houghton Pond using the related stage-discharge and area-volume curves which are shown in Appendix D. It is assumed that the stoplogs which existed at the time of the site visit would be left in place, since they would be difficult to remove during high flow.

The test flood outflow, which was estimated to be 1,550 cfs, would occur when the water surface elevation in the pond is approximately El. 183.5. This is about 2.5 ft. above the top of the dam. The preliminary computations also show that the top of the stoplogs at the spillway would be submerged by about 2.6 ft. Excluding the effect of tailwater, the capacity of the existing main and auxiliary spillways is estimated to be about 280 cfs or 18 percent of the test flood outflow.

It can be concluded, therefore, that the spillway structures at Houghton Pond Dam are inadequate to pass the test flood without overtopping the dam.

f. Dam Failure Analysis. Based on Corps of Engineers Guidelines for Estimating Dam Failure Hydrographs, and assuming that a failure would occur along 40 percent of the dam length, the peak failure outflow is estimated to be 2,360 cfs. Under this flow the downstream channel banks would be flooded by a 3 to 5 ft. depth of water as shown in Page D-8, Appendix D.

A business district upstream of Washington Street (Route 16) which includes a restaurant, a bicycle shop, a transmission repair shop, and a Shell gasoline station on the left bank, and a fire station, a variety shop and a mini-market on the right bank are expected to be significantly flooded. In addition, one dwelling on the downstream side of Washington Street and two dwellings on Woodland Street would be flooded to a lesser degree. The area downstream of the former Penn Central railroad was not included in this study.

It can be concluded that in the event of a dam failure, a potential for loss of a few lives and appreciable property damages exists at this dam site and the hazard potential classification can be considered significant, in accordance with Corps of Engineers Guidelines.

SECTION 6 - STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations. There was no visual evidence of settlement, excessive lateral movement or other signs of significant structural instability in the earth embankment to the right of the spillways. The Houghton Pond Dam embankment has a relatively broad crest and an apparently stable downstream wall. The configuration of the embankment compares favorably with other dams of similar type construction in New England which have proven to be stable. Therefore, the embankment is considered to be adequately stable at this time for normal pond levels under static loading conditions and no evidence of seepage.

The concrete main spillway (outlet) appears to be stable. Additional information is needed to assess the effect on structural stability of the observed seepage occurring through the auxiliary spillway.

b. Design and Construction Data. There are no design or construction records to aid in the evaluation of structural stability of the embankment or the spillways.

c. Operating Records. No operating records are available to aid the evaluation of structural stability.

d. Post-Construction Changes. The different methods of construction observed indicate that the concrete spillway (outlet) was constructed some time after the field stone ogee spillway. The concrete piers observed offshore and the keyed construction joint at the end of the right wall of the concrete spillway suggest that an additional structure was built, possibly at the same time as the concrete spillway, and later removed.

e. Seismic Stability. Houghton Pond Dam is located in a Seismic Zone 2 and in accordance with Recommended Phase I Guidelines does not warrant seismic analysis.

SECTION 7 - ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. The visual examination of Houghton Pond Dam revealed that the structure is in fair condition. Although there are no signs of impending structural failure or other conditions which would warrant urgent remedial action, several deficiencies were noted.

Based on the results of computations included in Appendix D and described in Section 5, the spillway is not capable of passing the test flood, which for this structure is the 1/2 PMF. The 1/2 PMF outflow of 1,550 cfs (inflow 1,800 cfs or 690 csm) would overtop the dam by about 2.5 ft. With the water level at the top of dam and the existing stoplogs 6.5 ft. in height in the main spillway, the total spillway capacity is about 280 cfs, which is 18 percent of the test flood outflow.

b. Adequacy of Information. This evaluation of the dam is based primarily on visual examination, preliminary hydraulic and hydrologic computations, consideration of past performance and application of engineering judgement. Generally the information available or obtained was adequate for the purposes of a Phase I assessment. However, it is recommended that additional information regarding the seepage occurring at the auxiliary spillway be obtained as outlined in Section 7.2.

c. Urgency. The recommendations for additional investigations and remedial measures outlined in Section 7.2 and 7.3, respectively, should be undertaken by the Owner and completed within one year after receipt of this report.

d. Need for Additional Investigation. Additional investigations should be performed by the Owner as outlined in Section 7.2.

7.2 Recommendations

It is recommended that the Owner engage a registered professional engineer to undertake the following investigations:

1. Perform hydraulic/hydrologic studies to determine the design and construction necessary to significantly increase the spillway discharge capacity of this dam. The studies should include the design of a low-level outlet which may be used to control pond level and drain the pond in times of emergency.

2. Determine the geometry and construction materials of the auxiliary spillway and perform a structural stability analysis based on the results of the investigation.

3. Investigate and evaluate the seepage that is occurring from behind the ogee-shaped auxiliary spillway. The investigation should include a comparison of the location, character and amount of seepage flow at times of high and low pond levels to determine the path of seepage, its effect on the structural stability of the spillway and the method of repair.

4. Evalute the effect of clearing the earth embankment and downstream toe area for at least 20 ft. beyond the dam of trees and the need for removing the tree roots from the embankment.

The Owner should then implement corrective measures on the basis of this engineering evaluation.

7.3 Remedial Measures

The dam is generally in fair condition, and it is considered important that the following items be accomplished:

a. Operation and Maintenance Procedures. The following should be undertaken by the Owner:

1. Place fill at the bare, severely eroded left abutment to restore grade to the level of the concrete spillway walls. It may be necessary to modify the downstream end of the left spillway wall to retain the abutment fill at this level. It is important to then establish turf to resist erosion and mow the area at least twice a year to keep it clear of brush.

2. Clear the earth embankment and downstream toe area of trees and brush and grade the top of the embankment as determined necessary by the engineering studies recommended in Section 7.2. Establish turf on the embankment crest to resist erosion and mow it at least twice a year.

3. Repair the upstream stone wall in areas where it has collapsed, and replace missing capstones on the downstream wall.

4. Remove the brush and vegetation in the approach channel upstream of the auxiliary spillway weir and on the downstream face of the weir.

5. Replace the stones missing from the ogee-shaped downstream face of the auxiliary spillway with consideration given to grouting the voids between the stones.

6. Replace the existing stoplogs (remains of a wooden gate) which are in poor conditions and leaking in a manner to assure ease of removal.

7. Remove debris in the channel below the spillways.

8. Prepare an operations and maintenance manual for the dam. The manual should include provisions for annual technical inspection of the dam and for surveillance of the dam during periods of heavy precipitation and high pond levels. The procedures to be done on the dam to ensure safe, satisfactory operation and to minimize deterioration of the facility.

9. Develop a written emergency preparedness plan and warning system to be used in the event of impending failure of the dam or other emergency conditions. The plan should be developed in cooperation with local officials and downstream inhabitants.

7.4 Alternatives

Not applicable.

APPENDIX A - INSPECTION CHECK LIST

VISUAL INSPECTION PARTY ORGANIZATION

NATIONAL DAM INPSECTION PROGRAM

Dam: Houghton Pond

Date: 14 May 1979

Time: 1215 to 1600

Weather: Overcast with light rain showers, temperature high 60's

Water Surface Elevation Upstream: Approx. El. 178.2 NGVD

Stream Flow: 0.2 ft. over stoplogs, estimated 10 cfs

Inspection Party:

Harl P. Aldrich, Jr.	- Soils/Geology
Richard A. Brown Haley & Aldrich, Inc.	
A. Ulvi Gulbey	- Hydraulic/Hydrologic
Robert P. Howard	- Structural/Mechanical
Robert H. Sheldon Camp, Dresser & McKee, Inc.	

Present During Inspection:

No representatives of owner present

VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: Houghton Pond DATE: 14 May 79

AREA EVALUATED	CONDITION
DAM EMBANKMENT	
Crest Elevation	Approx. 181.0 to 181.5
Current Pool Elevation	El. 178.2 (NGVD Datum)
Maximum Impoundment to Date	Unknown
Surface Cracks	None observed
Pavement Condition	No pavement present
Movement or Settlement of Crest	None observed
Lateral Movement	Downstream wall for a distance of 35 ft. from the auxilary spillway is tilted out at the top by 3 to 6 in. Otherwise, none observed
Vertical Alignment	Satisfactory; crest relatively level
Horizontal Alignment	Satisfactory; downstream wall in fair alignment
Condition at Abutment and at Concrete Structures	Satisfactory
Indications of Movement Structural Items on Slopes	No structural items on slopes
Trespassing on Slopes	No restrictions; well-worn foot path down crest of embankment
Animal Burrows in Embankments	None observed
Vegetation on Embankment	Brush and saplings; one large oak on crest, 12 in. diameter
Sloughing or Erosion of Slopes or Abutments	Severe erosion on upstream side of dam from 25 to 30 ft. right of auxiliary spillway. Also, left of main spillway severe erosion of the left abutment has occurred (see text)
Rock Slope Protection - Riprap Features	Stone wall on upstream side of embankment has collapsed in some areas; in others, stones are missing
Unusual Movement or Cracking at or near Toes	None observed

VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

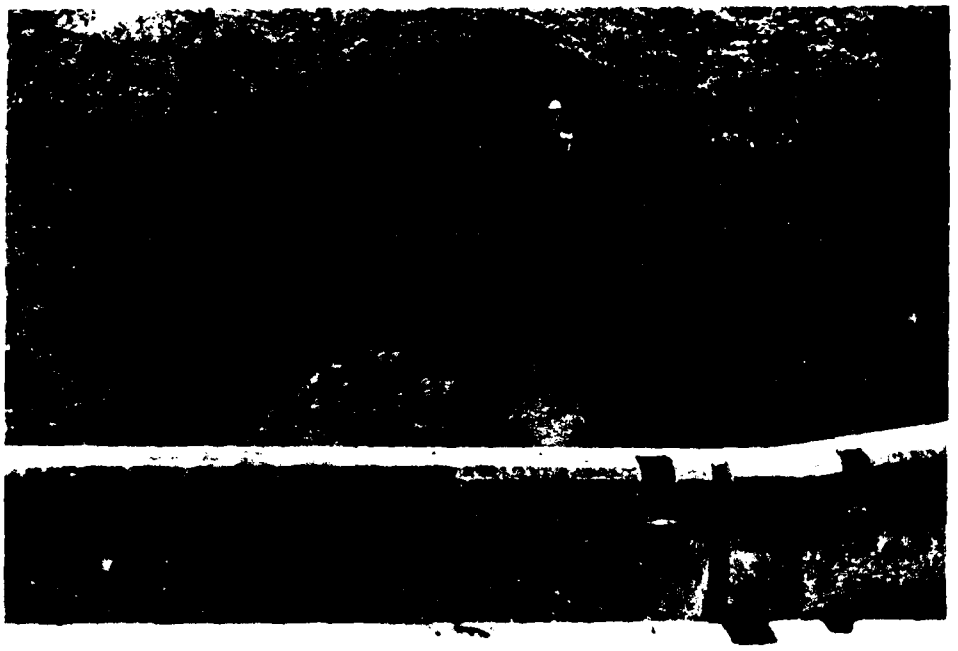
DAM: Houghton Pond DATE: 14 May 79

AREA EVALUATED	CONDITION
Piping or Boils	None observed
Foundation Drainage Features	None known to exist
Toe Drains	None known to exist
Instrumentation Systems	None
OUTLET WORKS - MAIN SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	
General Condition	Approach to weir formed by concrete spillway side walls extending into pond in good condition
Loose Rock Overhanging Channel	Not applicable
Trees Overhanging Channel	None
Floor of Approach Channel	Submerged, not visible
b. Weir and Training Walls	
General Condition of Concrete	General condition of the main spillway (concrete inlet) is good, with the exception of the stoplogs which are poor
Rust or Staining	Minor rusting and staining observed
Spalling	Some minor spalling observed
Any Visible Reinforcing	None observed
Any Seepage or Efflorescence	None observed
Drain Holes	None observed
Stoplogs	The stoplogs at the main spillway (concrete outlet) are in poor condition. The remains of two wooden stems bolted to the lower half of the stoplogs were observed. There was no flow of water over the stoplogs and several leaks observed between the lower stoplogs

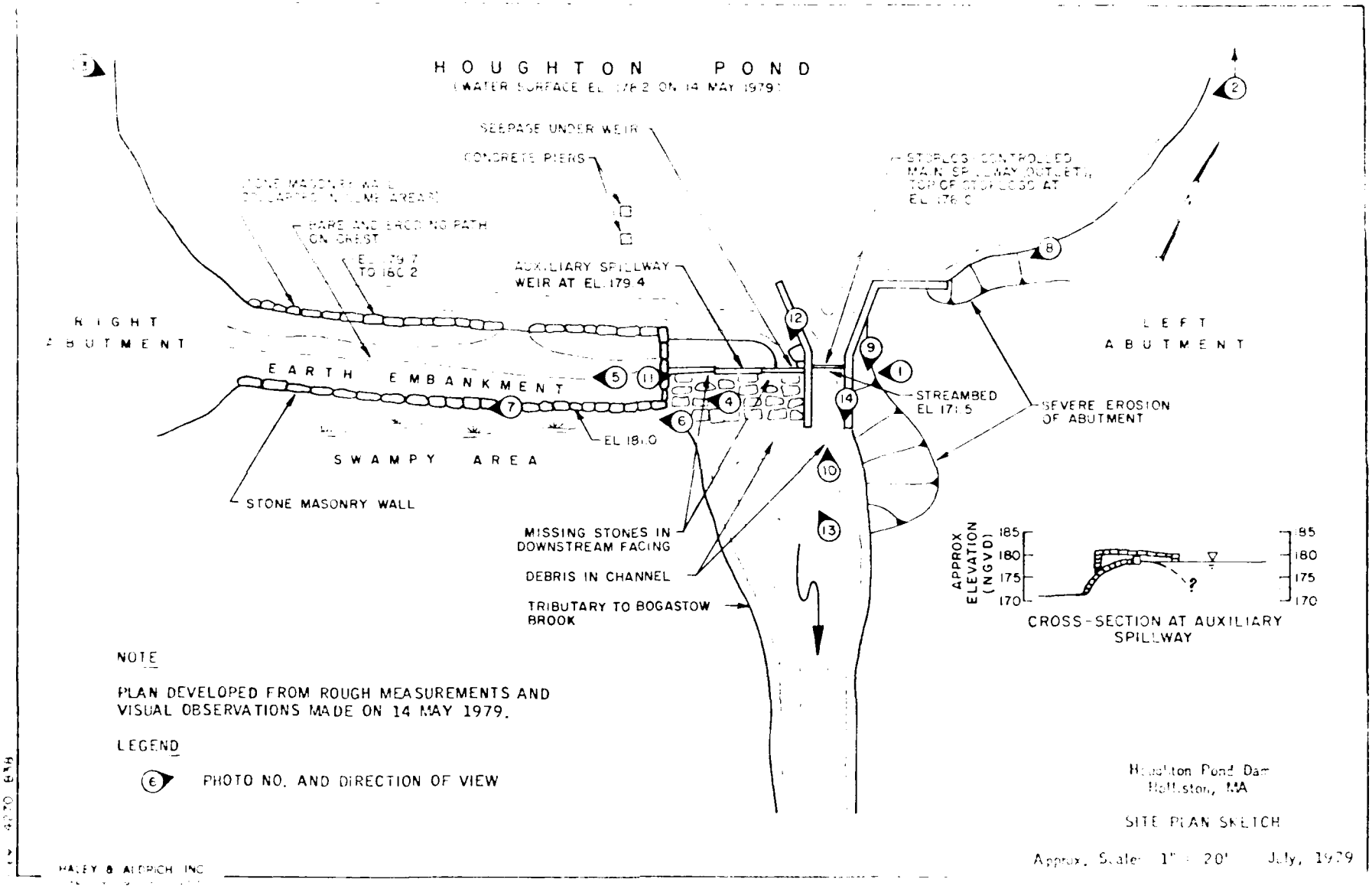
VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: Houghton Pond DATE: 14 May 79

AREA EVALUATED	CONDITION
Others	There are blockouts with anchor bolts on either side of the stop-log slots at the top of both spillway walls. A construction joint with reinforcing bars extending beyond the joint on the pond side of the right training wall Approximately 20 ft. offshore from the right of the auxiliary spillway are two concrete piers with bolts
c. Discharge Channel	
General Condition	General condition was good to fair
Loose Rock Overhanging Channel	None observed
Trees Overhanging Channel	Several trees are overhanging channel
Floor of Channel	Water flowing in channel. Brush and grass growth in channel
Other Obstructions	Debris and stone rubble observed in channel
OUTLET WORKS - AUXILIARY SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	
General	Discharge is directly from pond
Loose Rock Overhanging Channel	Not applicable
Trees Overhanging Channel	Several trees on embankment to the right
Floor of Approach Channel	A strip of ground on the upstream side of the capstone weir is covered with brush and small saplings up to 4 in. in diameter. Otherwise, submerged



1. Overview of Houghton Pond Dam from left abutment


HOUGHTON POND
(WATER SURFACE EL. 178.2 ON 14 MAY 1979)
SEEPAGE UNDER WEIR
CONCRETE PIERS
STOPLOG CONTROLLED MAIN SPILLWAY OUTLET; TOP OF STOPLOGS AT EL. 176.0
STONE MASONRY WALL (PLANTED WITH TREES AND SHRUBS)
BARE AND ERODED PATH ON CREST
EL. 179.7 TO 180.2
AUXILIARY SPILLWAY WEIR AT EL. 179.4
RIGHT ABUTMENT
LEFT ABUTMENT
EARTH EMBANKMENT
STREAMBED EL. 171.5
SEVERE EROSION OF ABUTMENT
EL. 181.0
SWAMPY AREA
STONE MASONRY WALL
MISSING STONES IN DOWNSTREAM FACING
DEBRIS IN CHANNEL
TRIBUTARY TO BOGASTOW BROOK
APPROX ELEVATION (NGVD)
185
180
175
170
?
CROSS-SECTION AT AUXILIARY SPILLWAY
NOTE
PLAN DEVELOPED FROM ROUGH MEASUREMENTS AND VISUAL OBSERVATIONS MADE ON 14 MAY 1979.
LEGEND
PHOTO NO. AND DIRECTION OF VIEW
Houghton Pond Dam
Hollliston, MA
SITE PLAN SKETCH
Approx. Scale: 1" = 20'
July, 1979
HALEY & ALDRICH, INC.

APPENDIX C - PHOTOGRAPHS

PHOTOGRAPHS

3. The uncontrolled spillway has a small leak near the top of the stone, which should be plugged with cement mortar.

4. Some riprap and fill is needed near the top and downstream side of the dam. About three (3) cubic yards of fill is needed to restore the top and downstream side of the dam.

5. Trees and brush are too close to the dam and spillway. These should be cut back from the top of the slope of the dam to avoid further deterioration, especially, those trees and brush growth at upstream face of the dam and spillway.

In order to economize, most the repair work may be done by Town forces.

If we can be of any further assistance before, during or after the repair process, please do not hesitate to contact us.

Very truly yours,

WHITMAN & HOWARD, INC.

T. T. Chiang

Dr. T.T. Chiang, P.E.
Chief Hydraulic Engineer

Edward R. Clemons

Edward R. Clemons, L.A.
Associate

ERC/dfb

EST. — 1869 INC. 1924

Robert T. Jones, *President*
Paul C. Buckman, Jr., *Treasurer*
Howard R. Perkins, *Manager*

Anthony Chiaravalotti
Elias A. Cooney
Brewster W. Fuller
Robert E. Hickman
Myron F. Howard
Frederick O. A. King, Jr.
James T. McDonough

Archer T. Lucchino, *Controller*
James A. S. Walker, *Arch. Officer*

WHITMAN & HOWARD, INC.

Engineers and Architects

45 WILLIAM STREET, WELLESLEY, MASS. 02181 • TEL: 617-237-5000

ASSOCIATES

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Arthur Lizzio
James A. Little
Edward R. Mayer
James F. Murphy
Joseph A. Murphy
Robert L. Wyman

October 30, 1978

Conservation Commission
Town of Holliston
Town Hall
Holliston, MA 01746

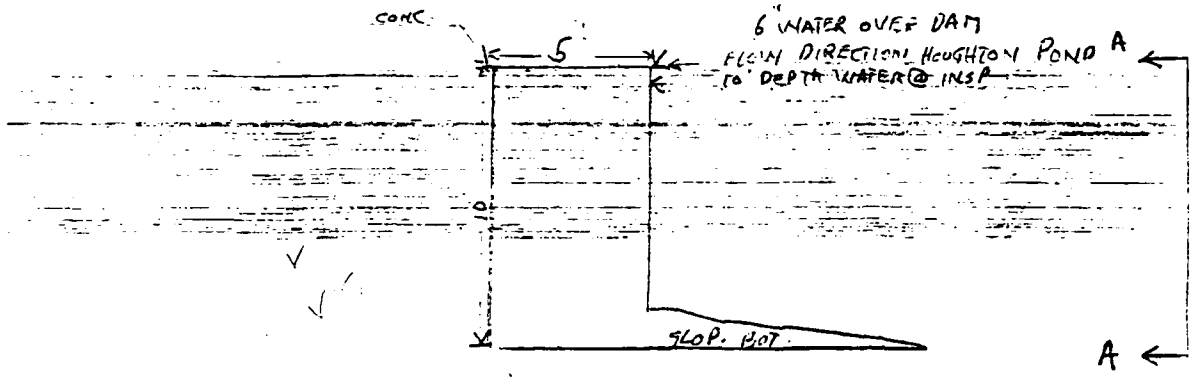
Gentlemen:

As requested, we have inspected the Houghton Pond dam and spillway and our findings are as follows:

1. The dam is in fair condition. There are two small leaks at the bottom of the spillway of the embankment on the right side looking downstream. The leaks are very minor and can be stopped by using cement grouting on the downstream side of the dam.

2. Major leakage occurs at the stop logs of the control spillway. The boards are old and should be completely replaced with either all new boards or a concrete wall to a chosen elevation and one or two new boards above the concrete, depending how the spillway is used. The repair work could be accomplished by either release of the water in the pond to the required elevation or by placing a sandbag dam on the upstream side of the control spillway channel.

4-9-136-6



X SECTION AA

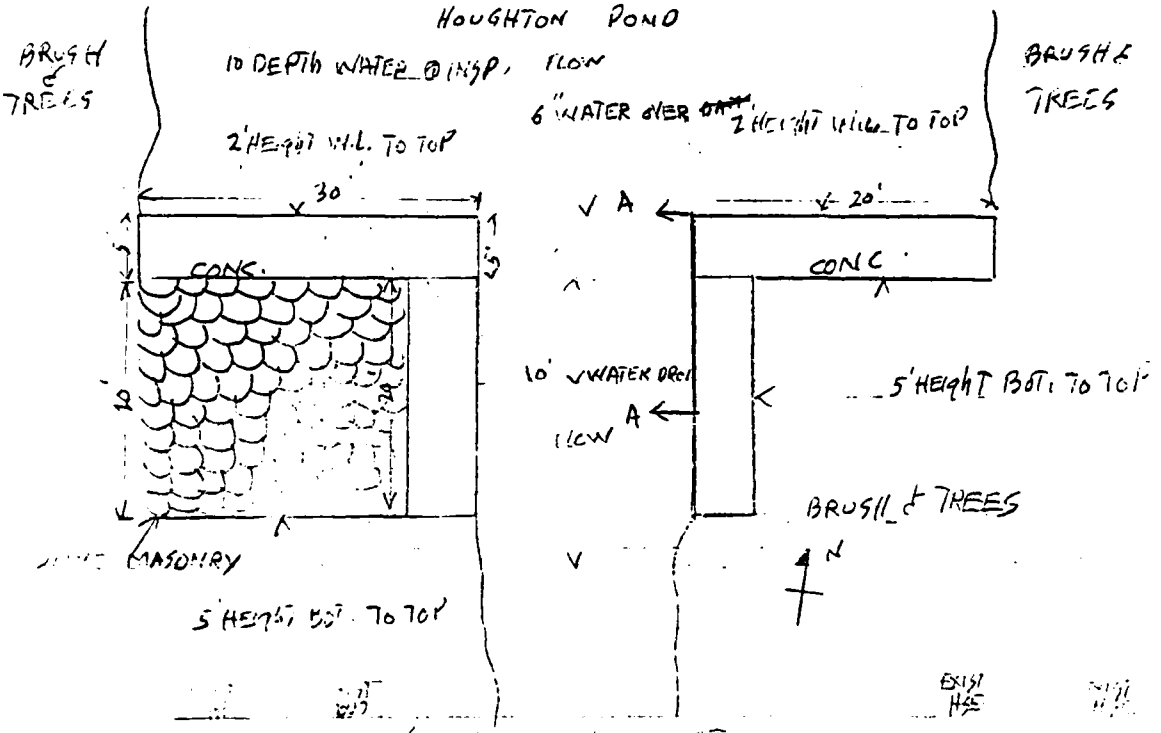
SKETCH NOT TO SCALE

DAM NO. 4-9-136-6

10. Risk to life and property in event of complete failure.

No. of people EST. 50
No. of homes 15
No. of businesses NONE
No. of industries Type
No. of utilities Type
Railroads
Other dams FACTORY POND DAM, 4-9-136-7 ½ MILE DOWNSTREAM
Other

Attach sketch of dam to this form showing section and plan 8½" x 11" Sheet.



TOP VIEW

SKETCH NOT TO SCALE

DESCRIPTION OF DAM
DISTRICT #4

Submitted by FRANCIS H. PARÉ & ADAM Z. PIZANI
Date 8/15/73

Dam No. 4-9-136-6
City/Town HOLLISTON 01746
Name of Dam HOUGHTON POND DAM

1. ~~Location: Topo Sheet No.~~ 27A
Provide 8½" x 11" in clear copy of topo map with location of Dam clearly indicated.

2. Year built: UNKNOWN   Year/s of subsequent repairs UNKNOWN

3. Purpose of Dam: Water Supply ____ . Recreational ✓
Irrigation ____ . Other ____

4. Drainage Area: 1 SQ. MI. 640 ACRES.

5. Normal Ponding Area: 12 acres; Ave. Depth 5'
Impoundment: 20 MIL. gals; 60 acre ft.

6. No. and type of dwellings located adjacent to pond or reservoir
i.e. summer homes etc. 3 PERMANENT HOMES & 1 BUSINESS 500' DOWNSTREAM

7. Dimensions of Dam: Length 60' Max. Height 12½'
Slopes: Upstream Face VERT.
Downstream Face "
Width across top 5'

8. Classifications of Dam by Material:
Earth ____ , Conc. Masonary ✓ , Stone Masonary ✓
Timber ____ , Rockfill ____ Other ____

9.
A. Description of present land usage downstream of dam: 80 % rural; 20 % urban.
B. Is there a storage area or flood plain downstream of dam which could accommodate the impoundment in the event of a complete dam failure
[illegible] ✓ [illegible]

DAM NO. 4-9-136-6

(22.) Remarks & Recommendations: (Fully Explain)

DAM IS IN GOOD CONDITION.
RECOMMEND NEW FLASHBOARDS.

(23.) Overall Condition:

1. Safe ✓
2. Minor repairs needed ✓
3. Conditionally safe - major repairs needed
4. Unsafe
5. Reservoir impounds no longer exists (explain)

Recommend removal from inspection list

DAM NO. 4-9-136-6

(8) Downstream Face of Dam: Condition: 1. Good ✓ 2 Minor Repairs_____

3. Major Repairs____ Urgent Repairs___

Comments:_____

(9) Emergency Spillway: Condition: 1. Good ✓ 2. Minor Repairs_____

3. Major Repairs____ 4. Urgent Repairs____

Comments:_____

(10) Water level @ time of inspection 0.3 ft. above ✓ below_____

top of dam_____ Principal spillway ✓

other_____

(11) Summary of Deficiencies Noted:

Growth (Trees and Brush) on Embankment BRUSH ON EMBANKMENT.

Animal Burrows and Washouts_____

Damage to Slopes or top of dam_____

Cracked or Damaged Masonry_____

Evidence of Seepage_____

Evidence of Piping_____

Erosion_____

Leaks_____

[illegible] of Debris in [illegible]

[illegible] Damaged Spillway

Other_____

INSPECTION REPORT - DAMS AND RESERVOIRS

(1.) Location: ~~City~~/Town HOLLISTON DAM NO. 4-9-136-6

Name of Dam HOUGHTON POND DAM Inspected by A.Z. PIZAN & F.H. PARE

Date of Inspection 8-16-'73

(2.) Owners: per: Ass. ✓ Prev. Inspection

-Reg. of Deeds Pers. Contact

	Name	St. & No.	City/Town	State	Tel.No.
1.	TOWN OF HOLLISTON	703 WASHINGTON ST.	HOLLISTON MASS. - 01746		429-5895
2.					
3.					

(3.) Carstaker: (if any) e.g. superintendent, plant manager, appointed by absentee owner, appointed by multi owners.

Name	St. & No.	City/Town	State	Tel.No.
SAME				

(4.) No. of Pictures taken NONE

(5.) Degree of Hazard: (if dam should fail completely)*

1. Minor 2. Moderate ✓

3. Severe 4. Disastrous

*This rating may change as land use changes (future development)

(6.) Outlet Control: Automatic Manual ✓

Operative ✓ Yes: no.

Comments:

Maint. ✓

Major Repairs Minor Repairs

Comments:

LIST OF AVAILABLE DATA
HOUGHTON POND DAM

Document	Content	Location
State inspection report, Dam No. 4-9-136-6	Report dated 16 August 1973, including description of dams and sketches	Mass. Dept. of Environmental Quality Engineering, Division of Waterways, 100 Nashua Street, Boston, MA 02114 and page B-2
Letter report by Whitman & Howard, Inc., Engineers and Architects, Wellesley, MA, dated 30 October 1978	Engineering evaluation of Houghton Pond Dam prepared for Conservation Commission, Town of Holliston	Conservation Commission, Town of Holliston, Town Hall, Holliston, MA 01746 and page B-8

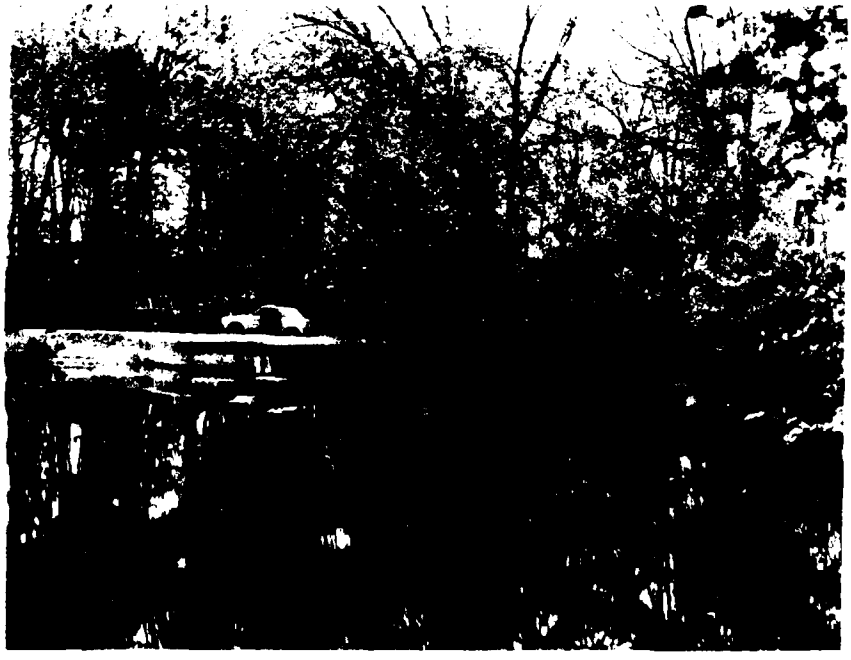
APPENDIX B - ENGINEERING DATA

VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: Houghton Pond DATE: 14 May 79

AREA EVALUATED	CONDITION
b. Weir and Training Walls	
General Condition of Concrete	Concrete training wall on left in good condition. The right training wall and the ogee-shaped spillway are of field stone masonry. A cut stone cap forms the weir. The general condition of the spillway is satisfactory. Some stones are missing, leaving large voids at the top of the spillway along the downstream side of the capstone
Rust or Staining	None observed
Spalling	None observed
Any Visible Reinforcing	None observed
Any Seepage or Efflorescence	About 6 ft. left of the concrete spillway wall, water was flowing under the capstone
Drain Holes	None observed
Vegetation	Heavy brush growth on pond side of the spillway and light vegetation growing on the downstream face between the stones
c. Discharge Channel	See Main Spillway

2. Overview of upstream side of dam



3. Upstream side of dam near spillways

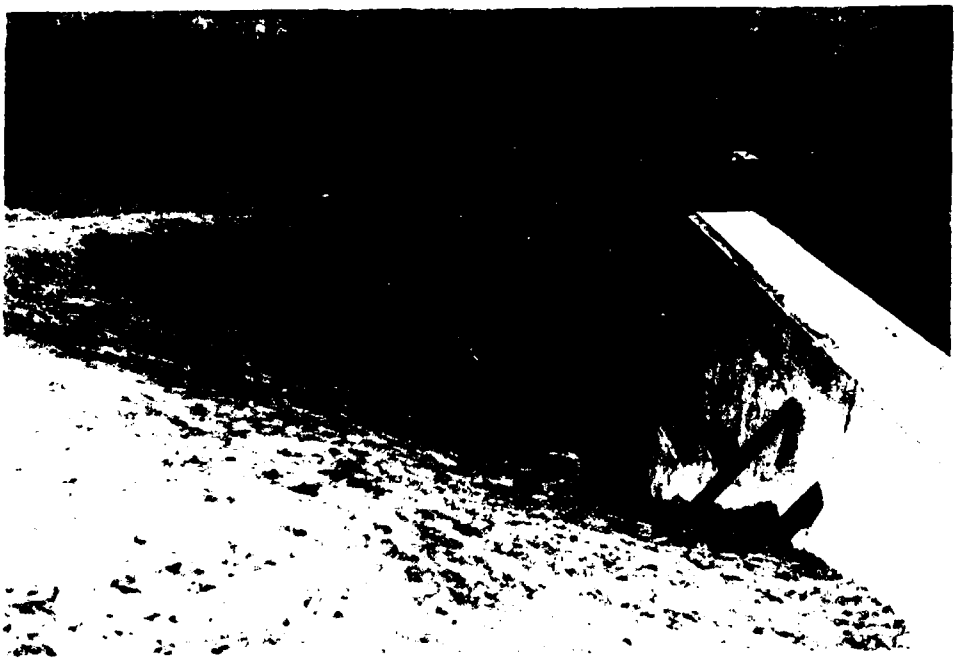
4. Crest of embankment with abutting auxiliary spillway in foreground

5. Bare and eroding path on crest of embankment

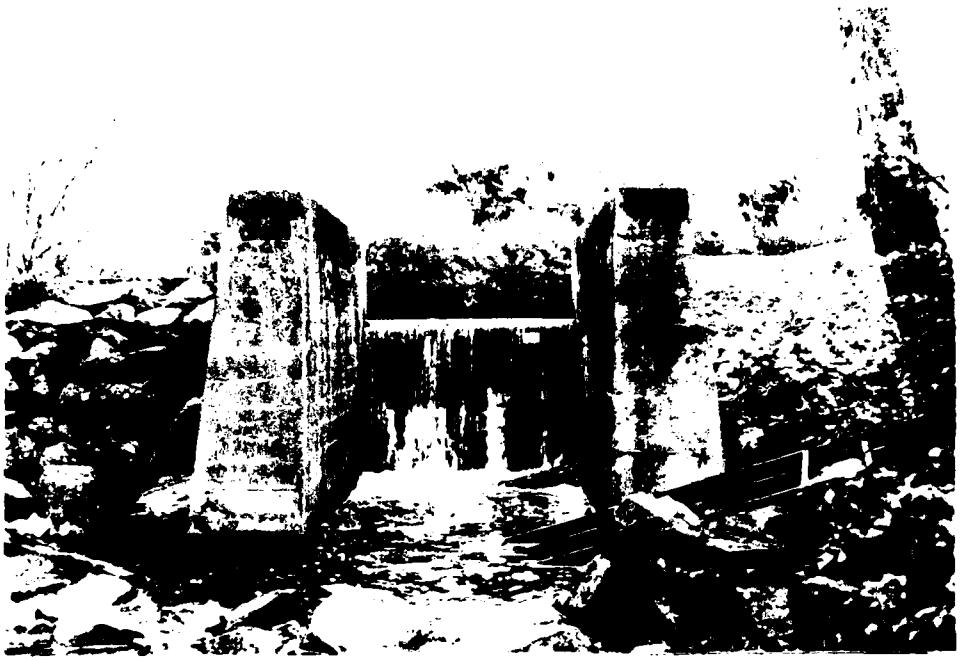
6. Section of downstream wall is tilted out, probably due to large oak tree at top

7. Capstones missing from downstream wall. Note trees at top and swampy vegetation at base

8. Concrete main spillway (outlet) structure. Note erosion at left abutment



9. Severe erosion of abutment at downstream end of left concrete wall



10. Leakage between stoplogs at main spillway (outlet)

11. Ogee-shaped, stone masonry auxiliary spillway right of concrete structure

12. Seepage under granite weir of auxiliary spillway

13. Stone facing on downstream side of auxiliary spillway

14. Downstream channel from main spillway (outlet)

APPENDIX D - HYDROLOGIC AND HYDRAULIC COMPUTATIONS

CAMP DRESSER & McKEE
Environmental Engineers
Boston, Mass.

CLIENT H & A | JOB NO 561-9-Rt-9 | PAGE 1
PROJECT COE Dam Inspection | DATE CHECKED 6/7/79 | DATE 6/1/79
DETAIL Houghton Pond Dam | CHECKED BY RHS | COMPUTED BY AUG

Size Classification

Hydraulic Height : $181.0 - 171.5 = 9.5\text{-ft} < 40.0\text{-ft}$

Storage : 132 acre-ft @ El. 181.0 < 1000 ac-ft

SIZE : SMALL

Hazard Potential Classification

In the event of a dam failure, a business district upstream of Washington Street (Route 16) which includes a restaurant, bicyle shop, transmission repair shop, and a Shell gasoline station on the left bank, and a fire station, a shop and a minimarket on the right bank are expected to be seriously flooded. In addition, one dwelling on the downstream side of Washington Street and two dwellings on Woodland Street would be flooded at a lesser degree (see pages D-7 and D-8). The hazard potential is considered significant, because of a potential for loss of few lives and substantial commercial residential and industrial property damages.

Test Flood Development

Size: Small ; Hazard: significant - Q_p = 100-yr to $\frac{1}{2}$ PMF

$Q_p = \frac{1}{2}$ PMF, selected.

Drainage Area = 2.6 sqmi = 1664 acres
Topography : 60 o/o rolling , 40 o/o flat

Peak Flow Rate = 1,380. cfs/sqmi

PMF = 2.6 · 1380 = 3,600 cfs

Q_p = 1,800 cfs = Test Flood Inflow

Dam Failure Analysis

Failure Flood Flow: $Qp_1 = \frac{8}{27} W_b \sqrt{g}\, Y_o^{3/2}$

$W_b = 0.4 \cdot 120 = 48'$ $\quad Y_o = 9.5'$ $\quad Qp_1 = 2,360$ cfs

Storage @ time of failure: 132 ac-ft @ El. 181.0 (Top of Dam)

Failure flood outflows were determined for two reaches:

Reach (1): between Dam and Washington St (Rt16):

$L = 530$ ft $\quad A_1 = 1220$ sf $\quad A_2 = 1900$ sf

$V_1 = 19$ ac-ft $\quad Qp_2 (trial) = 2,360 \left(1 - \frac{19}{132}\right) = 2,0$

WSE @ Washington St. = 178.0

$A_1 = 1,220$ sf $\quad A_2 = 1,530$ sf $\quad V_2 = 16.0$ ac-ft

$V_{av} = 17.5$ ac-ft $\quad Qp_2 = 2,360 \left(1 - \frac{17.5}{132}\right) = \underline{2,050}$ cfs

As shown on Hydraulic Profile, Page D-8, the area upstream of the Washington street would be subject to 4 to 5 feet of flooding. A restaurant, a bicycle shop, a transmission shop and a [illegible] gasoline station are on the left bank; and the Town's fire station, a variety shop and a minimarket are on the right bank.

Reach(2): From Washington Street to Woodland Street (downstream of Factory Pond):

Canal portion: L = 800 feet; section Area = variable with WSE.
Factory Pond: Stage-Discharge and Area-Volume Curves are shown on Pages D-9 and D-10, respectively.

$Qp_1 = 2,050$ cfs; $\quad Qp_2$ by trial and error:

$Qp_2 = 1150$ cfs $\rightarrow$ WSE in Factory Pond = 165.9
$V_{pond} = 130$ ac-ft
$V_{pond\text{-}normal} = 85$ ac-ft
$\Delta V = 45$ ac-ft

$V_{canal} = 8.5$ ac-ft $\quad Qp_2 = 2,050 \left(1 - \frac{8.5+45}{115}\right) = 1,097$ cfs

Outflow from Factory Pond $\approx \underline{1,100 \sim 1,150}$ cfs.

2 dwellings, upstream of Woodland st would be flooded with about 3.0-ft

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PAGE 7
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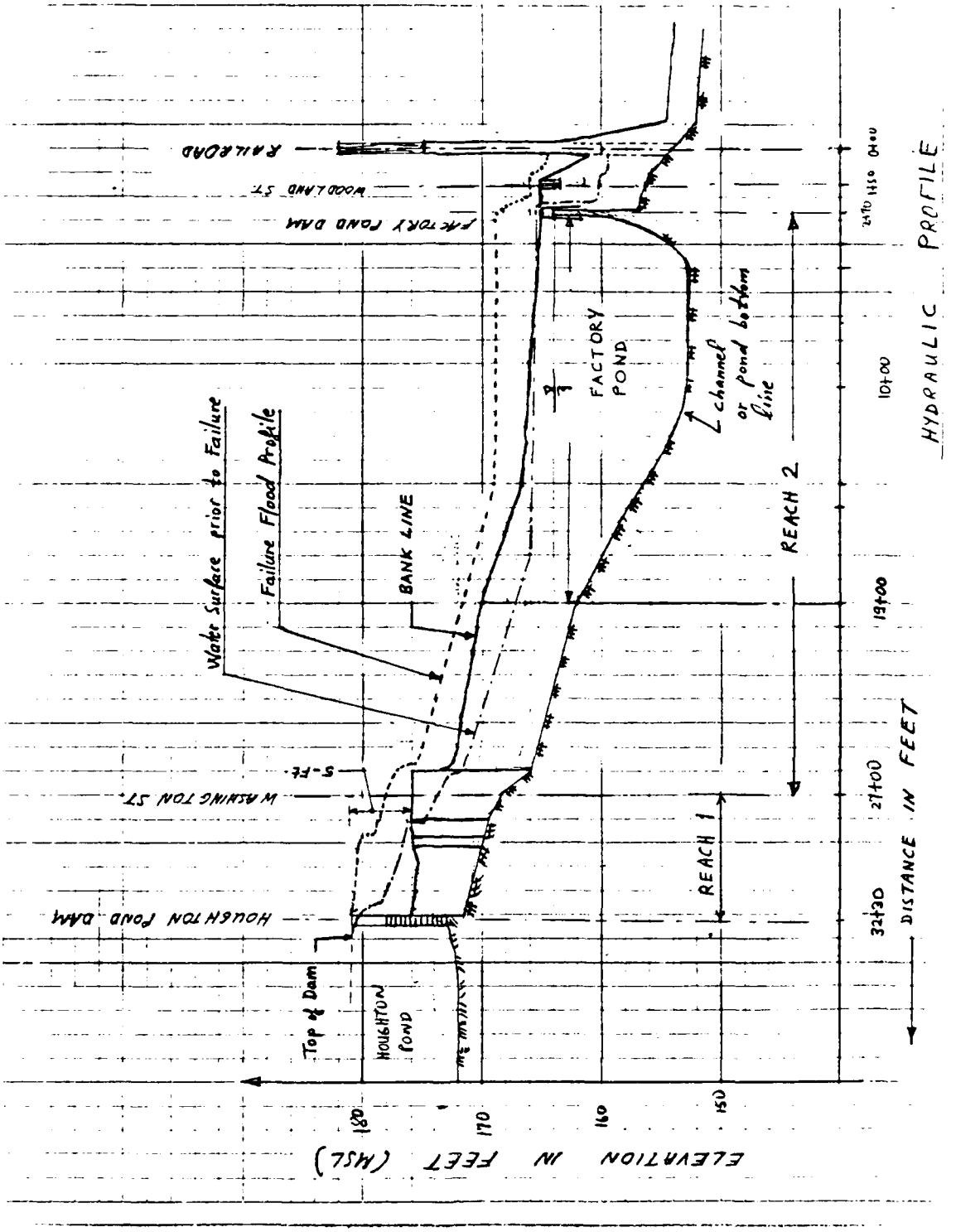

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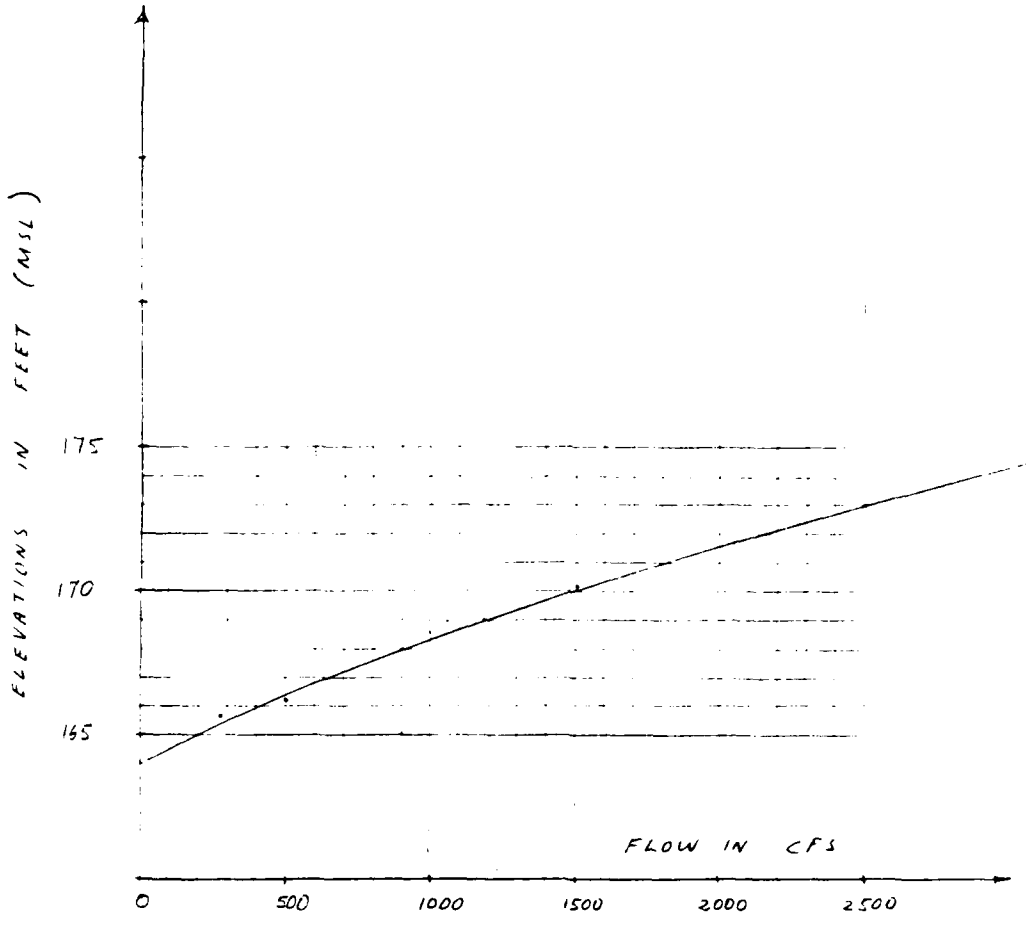

STAGE - DISCHARGE

FACTORY POND DAM & SPILLWAY

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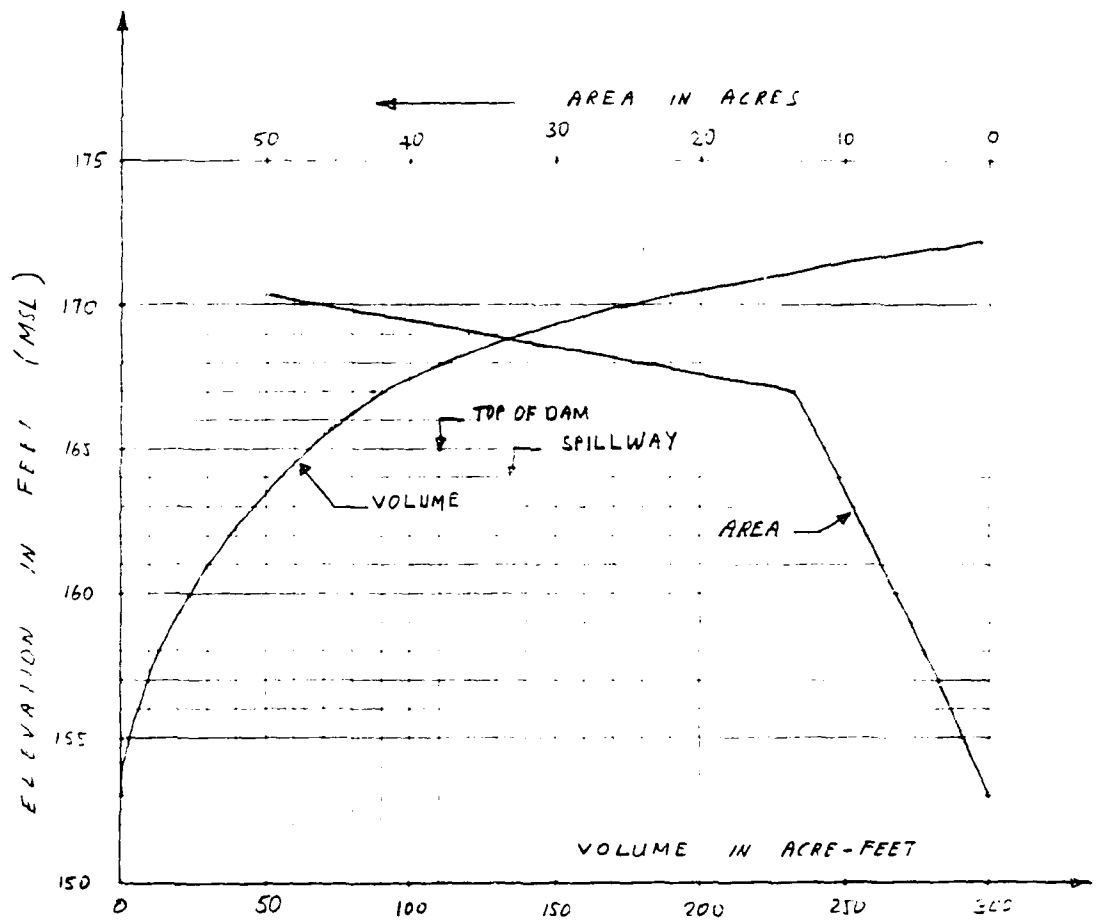

FACTORY POND

AREA - VOLUME CURVE

of water.

It is concluded that in the event of a dam failure potential for loss of lives exists and excessive damages to residential, industrial and commercial properties are expected to occur; therefore the hazard classification for this dam is considered high.

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DOWNSTREAM CHANNEL CROSS SECTIONS AND STAGE - DISCHARGE RELATIONS

D-12

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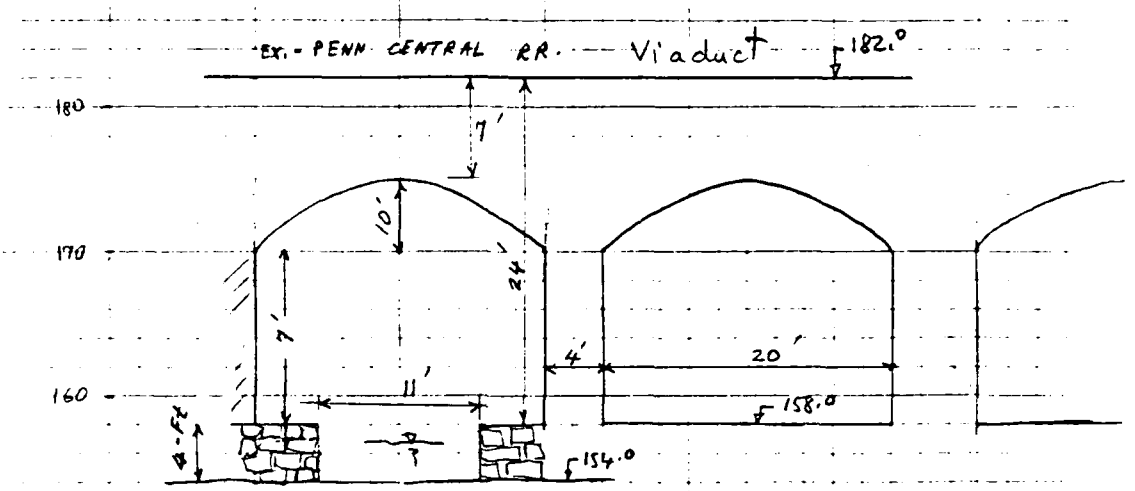
CROSS-SECTION @ RAIL ROAD

(3200 feet downstream of the dams)



Total number of Openings = 8

Stage - Discharge Relation

n = 0.03

S ≈ 0.0001 (substantial backflow from downstream is expected)

Discharge cfs	WSE
500	161.6
1,000	164.1
1,500	166.0
2,500	168.6
3,000	169.6

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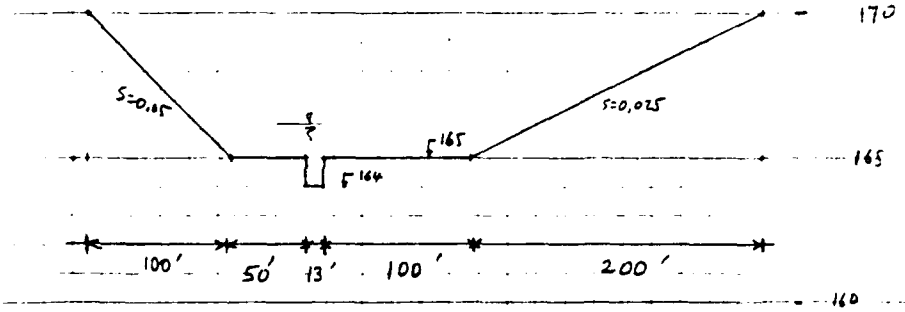
FACTORY POND SPILLWAY

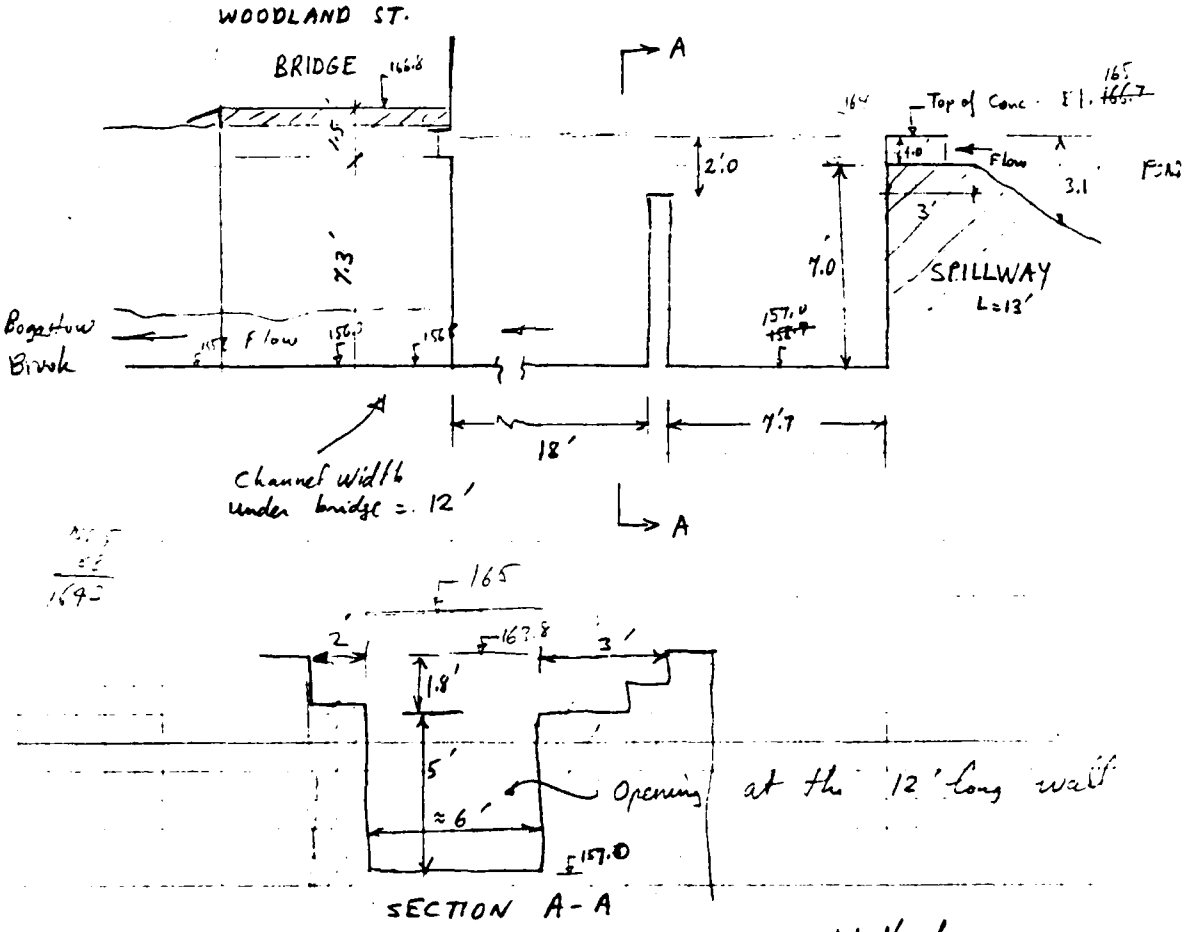


STAGE - DISCHARGE RELATION : $Q = 2.6 \times 13 \times h^{3/2} + 2.5 \times L \times (h-1)^{3/2}$

Q cfs	WSE @ Pond downstream of Spillway	Upstream of Spillway
280	160.8	165.7
1500	168.8	170.1
2500	171.5	173.0

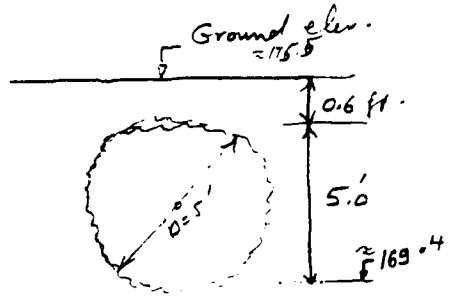
SECTION THROUGH

FACTORY POND OUTLET @ WOODLAND STREET BRIDGE



An old road exist on downstr side of the Woodland Str Bridge. This old road was collapsed and dislocated; its surface ranging with the channel 3.3' below the surface of the Woodland St.

Culvert Just before Rt 16 (Behind Shell stn. & Trans. Shop)



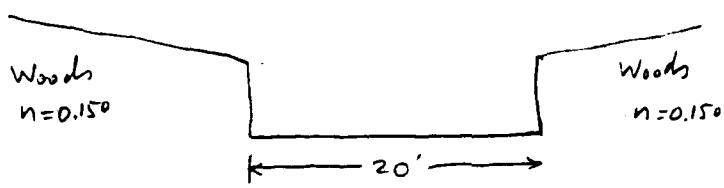
Left Bank

A restaurant
Bicycle shop
Trans. Shop
Shell stn.

Right bank

Fire station
A Shop
Main Market

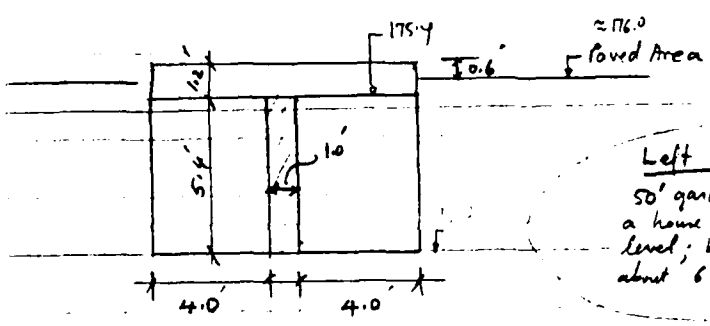
Channel section



n = 0.035

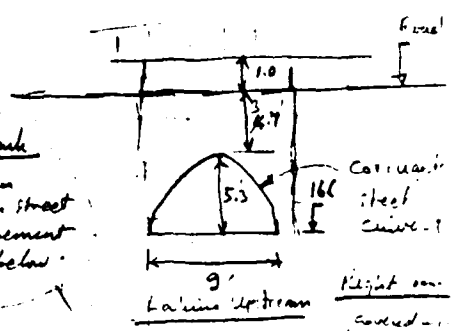
Concrete Culvert Under Rt 16 (about 80' dist of the Corrugated metal culvert)
(Washington St.)

Upstream end:



Left Bank
50' garden
a house on street level; basement about 6' below.

Downstream end



Right bank
covered with trees, rising fast

D.St. Channel: hanging trees; rocks n≅0.05
Further downst. the left bank is an open area - garden.

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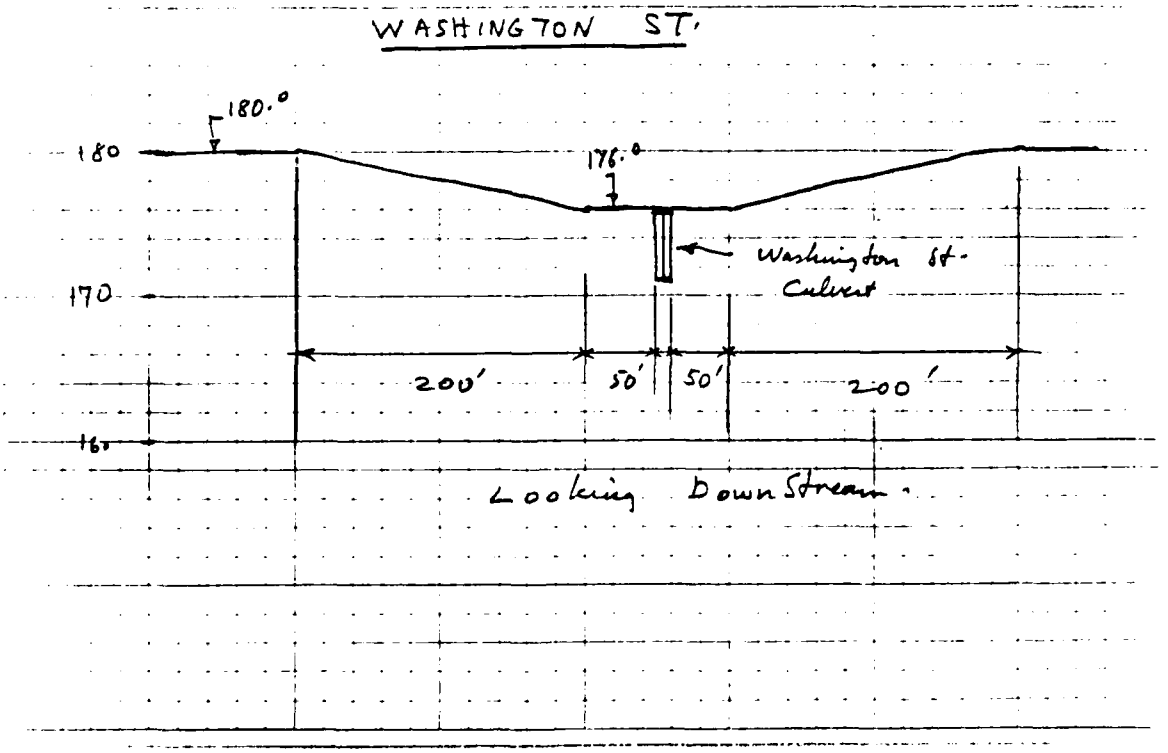
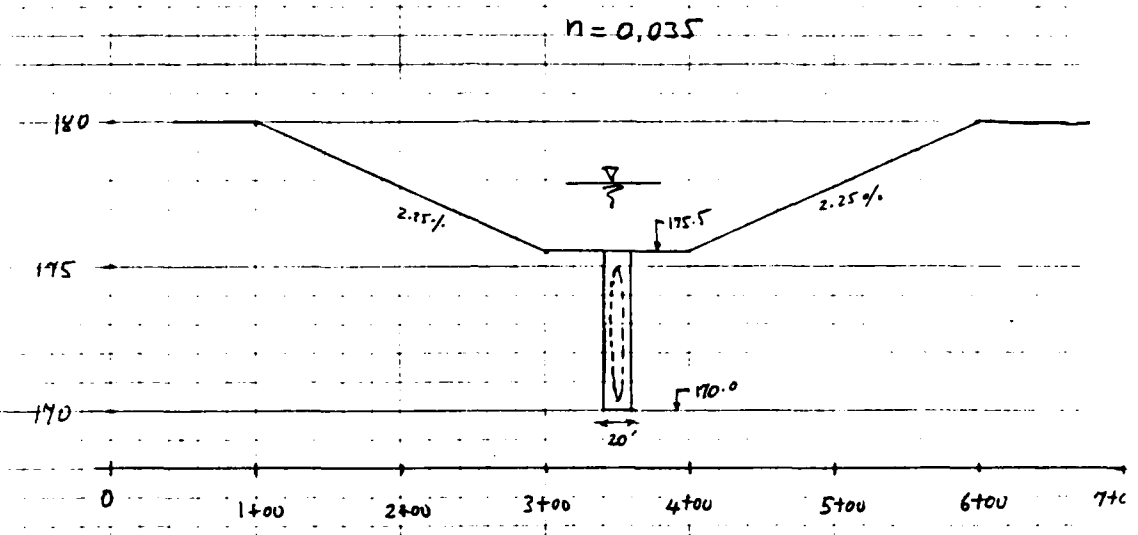
STAGE - DISCHARGE RELATION @ WASHINGTON STREET AND @ D=5' culvert

	WSE - Wash. St.		WSE - 5' Dia. Culvert	
Q (cfs)	d. Stream	Up Stream	d. Str.	Upstr.
280	174.9	176.4	176.5	177.1
1500	175.0	177.5	178.0	179.4
2,500	176.8	178.8	179.4	181.2



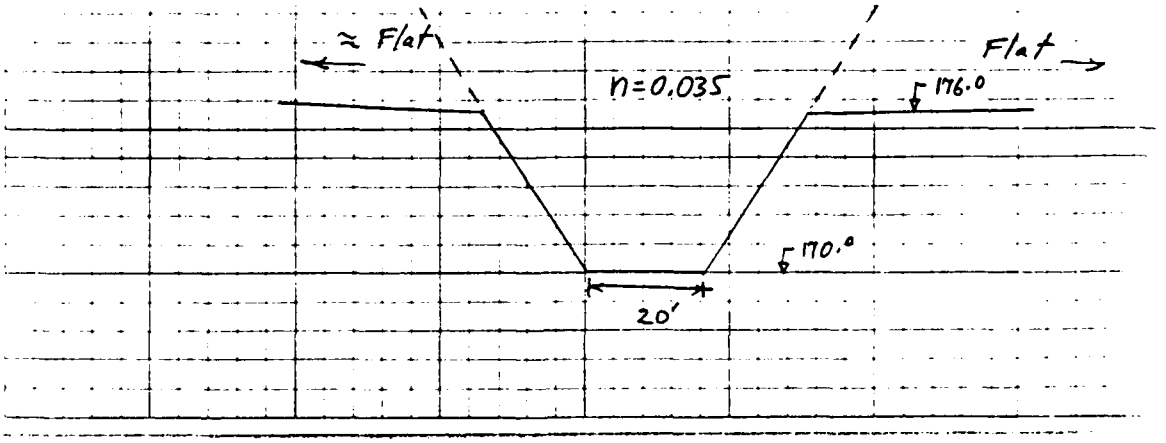
Downstream Channel (cont'd)

Cross Section at a point about 80 feet upstream of the upstream end of the Washington Street Culvert:



(Tailwater)

Cross Section @ Just downstream of the dam:



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STAGE - DISCHARGE RELATION - TAILWATER

Q (cfs)	WSE Tailwater	
280	177.2	< 178 (spillway not submerged)
1500	180.4	submerged by 2.4'
2,500	182.9	

Note: flow in the heavily wooded side channels are ignored.

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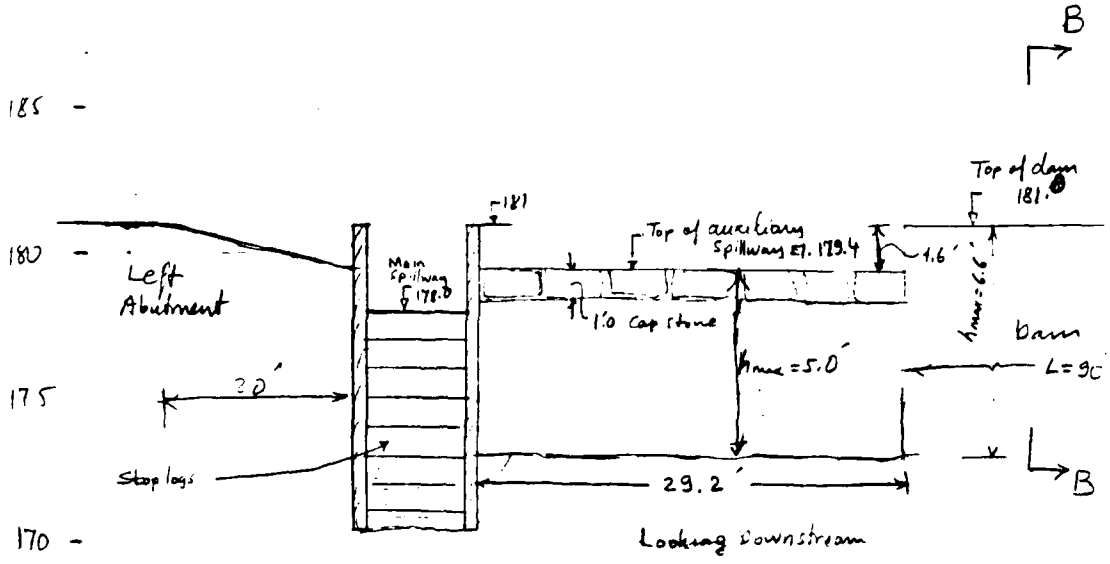
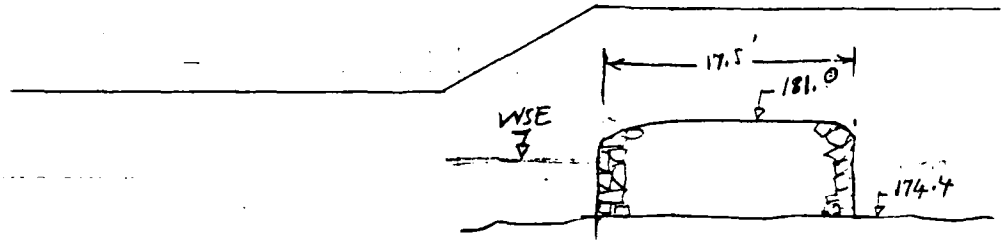
SECTIONS @ DAM

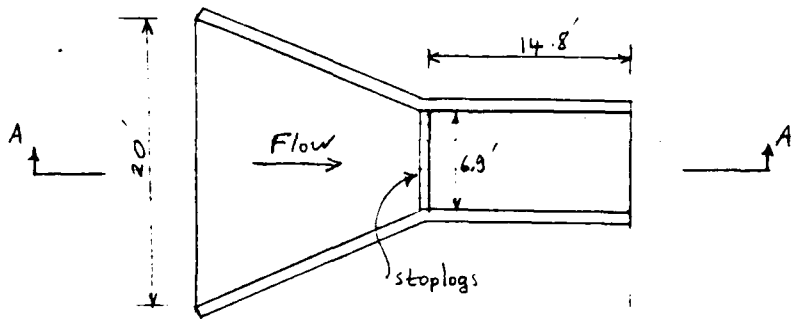


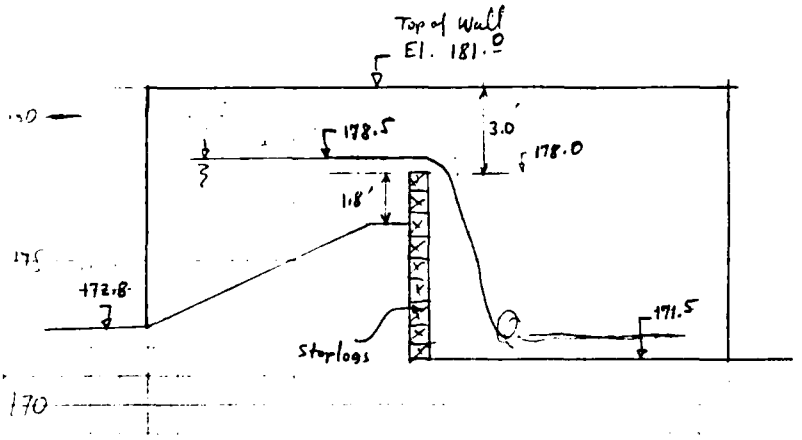
ELEVATION (Looking Downstream)



TYPICAL SECTION (B-B)
OF DAM

MAIN SPILLWAY STRUCTURE





SECTION A-A

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DETAIL Houghton Pond Dam

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FLOW OVER DAM AND SPILLWAY

Spillway Capacity: $q_1 = 3.5 \times 6.9 \times 3^{3/2} = 126$ cfs

$q_2 = 2.6 \times 29.2 \times 1.6^{3/2} = 155$ "

Total: 281 cfs WSE = 181.0

For Q = 500 cfs: dam would be overtopped.

Δh over dam = 0.6 ft:

$Q_{over} = 2.5 \times 90 \times 0.6^{3/2} = 105$ cfs

$q = 3.5 \times 6.9 \times 3.6^{1.5} + 2.6 \times 29.2 \times 2.2^{1.5} = 412$ cfs

Total: 517 cfs $\approx$ 500 cfs.

WSE in pond = 181.6 $\rightarrow$ Q = 500 cfs.

Q = 1500 cfs: Tail water elev = 180.4

Try: 3.0-ft overtopping:

$q_{over} = 1300$ cfs

$q_{spill} = 170$ cfs

$\Sigma q = 1470$ cfs $\approx$ 1500

WSE in the pond = 183.4

Q = 2,500 cfs. Tailwater El. 182.7 (dam submerged)

Try head differential = Δh

$Q_{over} = 2.5 \times 400 \times \Delta h^{3/2} = 1000\ \Delta h^{3/2}$

$Q_{spill} = 24 \cdot \Delta h^{3/2}$

$\Sigma Q = 1024\ \Delta h^{3/2}$

$2{,}500$ cfs $= 1{,}024\ \Delta h^{3/2}$ $\Delta h = 1.8'$ WSE = 182.7 + 1.8 = 184.5

INVENTORY OF DAMS IN THE UNITED STATES

(1) STATE	(2) IDENTITY NUMBER	(3) DIVISION	(4) STATE	(5) COUNTY	(6) CONGR DIST.	(7) STATE	(8) COUNTY	(9) CONGR DIST.	NAME	(10) LATITUDE (NORTH)	(11) LONGITUDE (WEST)	(12) REPORT DATE DAY	MO	YR
MA	444	NED	MA	017	03				HOUGHTON POND DAM	4212.7	7125.7	31	JUL	79

(13) POPULAR NAME	(14) NAME OF IMPOUNDMENT
	HOUGHTON POND

(15) REGION	(16) BASIN	(17) RIVER OR STREAM	(18) NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	(19) DIST FROM DAM (MI.)	(20) POPULATION
01	06	TR-BOGASTOW BROOK	HOLLISTON	0	12921

(21) TYPE OF DAM	(22) YEAR COMPLETED	(23) PURPOSES	(24) STRUCTURAL HEIGHT (FT.)	(25) HYDRAULIC HEIGHT (FT.)	(26) IMPOUNDING CAPACITIES MAXIMUM (ACRE FT.)	NORMAL (ACRE FT.)	DIST	OWN	FED R	PRV/FED	SCS A	VER/DATE
PGRECTGR	1898	R	10	10	132	55	NED	N	N	N	N	31JUL79

(28) REMARKS
22-PROBABLY OLDER

(27) D/S HAS	(29) SPILLWAY CREST LENGTH (FT.)	(30) TYPE	(31) WIDTH (FT.)	(32) MAXIMUM DISCHARGE (FT.)	(33) VOLUME OF DAM (CY)	(34) POWER CAPACITY INSTALLED (MW)	PROPOSED (MW)	(35) NAVIGATION LOCKS NO.	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)
1	150	C	37	280	1000											

(36) OWNER	(37) ENGINEERING BY	(38) CONSTRUCTION BY
TOWN OF HOLLISTON		

(39) REGULATORY AGENCY DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NONE	NONE	NONE	MA DPW

(40) INSPECTION BY	(41) INSPECTION DATE DAY	MO	YR	(42) AUTHORITY FOR INSPECTION
HALEY + ALDRICH, INC.	14	MAY	79	PUBLIC LAW 92-367 8AUG1972

(43) REMARKS